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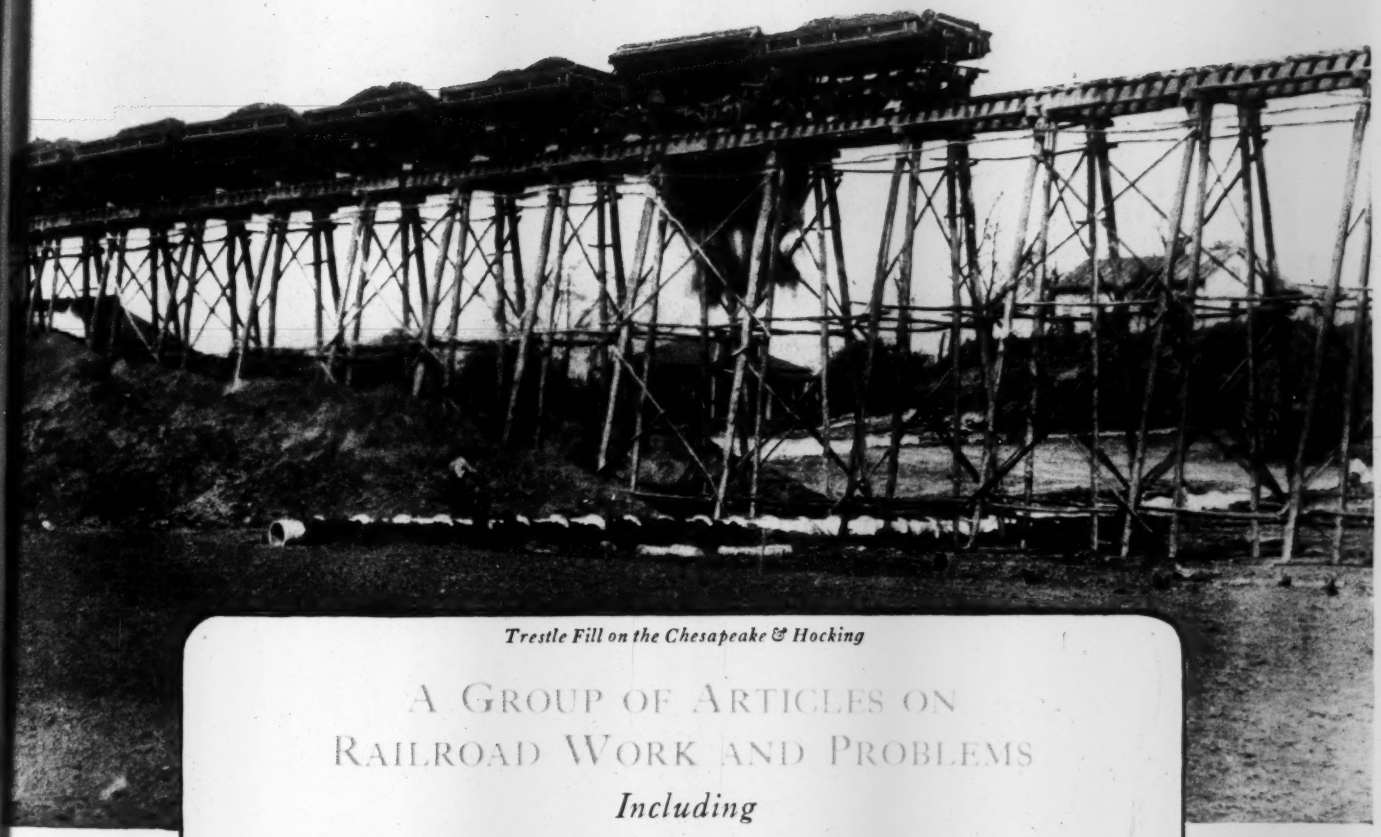

Trestle Fill on the Chesapeake & Hocking

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RAILROAD WORK AND PROBLEMS

Including

Building the Chesapeake & Hocking
Tracklaying on the Santa Fé
Piedmont & Northern Extension
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WILLARD CHEVALIER
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Managing Editor

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Wise Spending

DESPITE the period of low income through which the railroads of the country are passing they continue to spend more than two million dollars *a day* for new equipment and additions to their properties. Part of this money is new capital, but the major portion of it comes from income, return on investment which is being plowed in for the benefit of the property. This is a sound policy. Money spent for more efficient engines and larger cars, for better grades and alignment and for improved terminals even in times of low income is money well spent. Such spending improves the operating efficiency of the whole railroad system and so decreases the percentage of each dollar earned which must be spent for labor and maintenance costs. From a broader view, also, such spending is sound. The chief business of a railroad is to move freight, and the amount of freight in transit bears a direct relation to the amount of business the industries of the country are doing. By continuing to give business to these industries to the limit of their own capacity the railroads not only improve their properties but also stimulate new business for themselves.

The Cairo Situation

WHOEVER has studied the intricate conditions that make up the Mississippi flood-control problem has inevitably become aware of the vital part played in the whole problem by the situation of the city of Cairo. The whole reach of the river at the city and for miles above and below, together with the adjacent Ohio, presents a concentrated problem in the massing of flood waters and the throttling of the channel by a succession of narrow constrictions. The city, built on a sand spit, is in flood time virtually located in a sump surrounded by waters that rise many feet above street level. This situation underlies one of the crucial differences between the engineering plans developed by General Jadwin and those of the Mississippi River Commission. The commission recommended the Cairo problem for further study, because of the doubtful character of each one of the separate solutions presented. General Jadwin, on the other hand, chose to find a best solution at once, and after an intensive campaign of study on the ground decided upon the riverbank floodway from Bird's Point to New Madrid. Sharp criticism of this expedient has not been wanting, criticism directed both at the practicability and at the economics of the plan. Anxiety about the Cairo problem is the more justified because the flood flow predictions on which the engineering plans have been based are mere guesses, very slightly more dependable than those which have controlled Mississippi River work in the past; so that it is important to have a solution that will protect under all conditions and not merely prepare for a greater disaster. It was with these facts in mind that the Cairo situation was specially singled out for study by Mr. De Berard. His report on the facts of the situation, in this issue, gives the background of the two divergent solutions proposed and illuminates the problem remarkably. The report brings out clearly the need for extensive further study before the final decision is reached on what should be done at Cairo.

Freight Transfer Economies

A CONCRETE example of money spent to cut down operating costs is the transfer station for less-than-carload freight recently put into service in Chicago by the Chicago & Northwestern Railway, described elsewhere in this issue. Its function is the doubling up of the contents of lightly loaded cars to form practically fully loaded cars for specific destinations, thus releasing many cars as empties which otherwise would have been handled over long distances with their small loads, a very inefficient use of expensive equipment. It also serves to keep down the number of cars which the railroad company has to purchase to meet the requirements of its patrons. Moreover, within the transfer station itself labor costs have been reduced over those of the days of hand trucks by the use of light tractors and trains of small easy-running and self-tracking trailers. Freight is moved expeditiously by this means and labor is cut from many unskilled to a few skilled operators. With increased traffic and increasing need for operating economy there has come a marked development of such transfer systems. The field is especially suited to the railroad engineer who has not permitted himself to be content in his own narrow field but has studied the problems of his fellow officers in the operating department. An intimate knowledge of the operating difficulties to be overcome, backed by his knowledge of the possibilities of the material he has to work with and his ability to visualize the results he can obtain, makes such an engineer the best man in the railroad organization to tackle the design of such large transfer stations.

Remaking the Falls

A DEFINITE change is made in the long-discussed situation of Niagara Falls by an official recommendation to alter the flow of water over the falls by means of submerged weirs, in order to preserve their scenic beauty for the enjoyment of future generations. A special international Niagara board has reported to this effect in preliminary findings, which presumably will soon be followed by a final and more specific report. The findings represent an interesting though tardy recognition of the progressive change in the great cataract wrought jointly by nature and human action. It is tardy because the changes have long forced themselves on notice and their progress has been foreseen by all who gave the matter study. Erosive action, cutting back the vortex of the famous Horseshoe Fall and progressively baring its flanks, has distributed the flow and robbed the spectacle of some of its impressiveness. Variations

of river flow and the draft of water for power no doubt contributed to the ultimate effect, though the magnitude of their influence is not clearly shown. Rainfall and the resulting river flow will ever be variable, however, and utilization of water for power is unlikely to decrease, rather will increase as the demand for power becomes greater. The only course open for maintaining the falls in their grandeur is to counteract the effects of corrosion. Fortunately the board finds that quite simple remedial measures are available—essentially the provision of artificial deflecting blocks and reefs in the stream bed above the falls to supplement the action of the natural reefs that constitute the rapids over which the water approaches the brink of the falls. The logic of the case is compelling, and one cannot but accept the board's conclusions. It is to be hoped, therefore, that the final report with fully elaborated recommendations may be completed soon. No doubt everyone will confess to a sentimental repugnance to the thought of remaking Niagara Falls; but in so far as this remaking is restoration of the grander condition of former days and assures future protection from the inroads of time, it is a necessary proceeding. Better, then, that it be done quickly.

Function Versus Form

HEARTENING emphasis is being laid by highway men these days on the problems of traffic as distinct from those of structural design and construction. This was clearly apparent both at the American Road Builders Association convention and at last week's meeting of the Association of Highway Officials of the North Atlantic States. Time was when a convention of highway engineers devoted most of its time to the design of cross-sections, to drainage, concrete mixtures and the technical merits of wearing surfaces. All of these are of essential importance and on no account to be neglected or slighted —but, after all, the function of a highway is to speed traffic. With our national investment in highways mounting to prodigious figures, with inappropriate layout and control too often hobbling the earning power of that investment, and with the resultant congestion drawing us into still greater expenditures, we are being forced to a more earnest consideration of operating efficiency as the touchstone of sound design and construction. And only when the highway engineer achieves a mastery of operating problems and economics can he hope to measure up to the responsibility laid upon him by the community. Every engineering problem is but an effort to solve some economic or social problem; highway engineering is no exception.

A Commercial Phenomenon

A STUDY of certain present-day commercial practices recently made by *Electrical World* indicates that the sharpened competition in industry and commerce during late months has brought into being a peculiar, undesirable phenomenon. It has been called purchaser profiteering, by analogy with the seller's profiteering that goes on in times of abnormal buying demand and shortage of supply. Enough well-authenticated instances were found in the study to prove the existence of this new business practice beyond doubt. In its typical form a purchasing agent first obtains a number of bids for a desired article or machine; then he privately represents to each bidder in turn that he is likely to be preferred but that another bidder offered a lower price, which he must meet in order to retain his advantage. By this process the bid prices are progressively forced down and ultimately the contract is awarded at a losing figure. The seller, thinking that one case of sharp competition justifies a small loss, finds that subsequent sales bring out still closer figuring, his competitors being keen to get their share of the business. Ultimately all of the business is done at losing prices, and the industries involved languish even while they are busy. It is obvious, of course, that business which loses money is headed toward an evil day, and that buyer as well as seller is a loser in the end. Definite methods of combating the untruthful practices at the bottom of this development have not yet been evolved, but as a beginning it is suggested that in all bidding on standard articles the original bids shall be opened for examination to all bidders—thus putting private purchasing on almost the same basis as competitive public contract letting. While the field of construction equipment appears to be less seriously involved, the situation is one that invites thought in all circles of industrial commerce, to the end that sound practices may be formulated before seriously injurious results have come about.

At the Parting of the Ways

UNTIL the early part of 1926 there was reason to doubt whether a federal law for the regulation of motor trucks and buses engaged in interstate commerce was desirable. Many persons believed that it was not; they held that such operations are local in character and that their regulation is a matter for the states to handle. But on March 2 of that year the Supreme Court decided that state regulatory bodies could not control the operation of such vehicles except with a view to safety and conservation of highway. That decision made some form of federal control inevitable. This is important to the public, which is to be served, as well as to the railroads, with which the new service competes. For the latter, indeed, it may have a much deeper significance than is at first apparent.

One of the first points Congress will have to decide is whether motor bus and truck companies engaged in handling interstate commerce are to be put into the same class as railroads in the matter of limiting the return they may earn upon their capital investment, a subject that inevitably leads to control of their capital structure, revenue, expenses and methods of keeping accounts. Curiously enough, this point is barely touched upon in the voluminous report on the subject of motor vehicle regulation recently made to the Interstate Commerce Commission by one of its examiners. It has, however, been raised indirectly by the Association of Railway Executives in a formal exception to some of the findings of the examiner. The examiner proposed that railroad companies be authorized to operate motor vehicles in interstate commerce and that revenues and expenses from such operation be accounted for as are the railroad companies' revenues and expenses from railroad operations, and that such revenues be declared to come within that provision of the interstate commerce act which stipulates that railroads must pay into the government one-half of their net income above a certain percentage. The railroad executives claim that if the return from their operation of motor vehicles is to be subjected to such limitations, their competitors in the same field must be similarly limited.

Is not this matter of regulating transportation agencies

to the point of limiting their return upon investment the most important in the present discussion? Before the problem of regulating the newer methods of transportation is solved may we not find that the complications which they introduce have shown us that we have gone too far in the regulation of the older methods?

It appears reasonable to suppose that no court would sustain a law that provides that one company, simply because it happens to be operating a railroad as well as motor vehicles, must turn over to the government part of its income from such motor vehicle operation, while another company, which operates only motor vehicles, is under no such obligation to the government. Nor is that all. Whether the report of the commission's examiner is accepted or not, the country is still faced with the fact that the motor vehicle has passed into a class where it is on a par with a railroad train as a necessary part of our transportation system. If, therefore, we are to continue to operate the railroads under the provisions of the transportation act, it appears to be an inescapable conclusion that we must do likewise with motor trucks or buses engaged in interstate commerce, in competition with the railroads in many instances. To do otherwise would be unfair discrimination against the owners of the railroad properties.

But here again the subject runs into new complications. If after nearly ten years of work and the expenditure of vast sums of money the government has not been able to make the recapture provisions of the transportation act effective in the case of any one of the relatively small number of railroad companies in this country, how can it expect ever to make similar provisions effective with the ever-increasing number of motor vehicle operating companies? Moreover, will not any attempt to do so put a needless restriction upon these necessary adjuncts to our transportation system?

Are we not, therefore, at the parting of the ways in the matter of transportation regulation? The recapture provision was written into the transportation act in an attempt to equalize the return upon properties of unequal earning capacity. So far it has been ineffective and has resulted only in much litigation. To attempt to apply similar provisions upon the motor vehicle companies would be worse. Should we not, therefore, abandon the whole recapture idea, merely prescribing that each transportation agency should follow present railroad practice in matters of accounting for their earnings, expenses and capital structure to either a state or a federal regulating body?

Economics and Distribution

TIME was when economics was the concern of scholars and was not recognized as something intimately related to efficiency in human affairs. That time is past. Today economic considerations are basic to all our thinking and form a part of every living study of events, methods and constructive plans. And so also the engineer must admit economic reasoning to his equipment and conduct his thinking with close reference to its teachings. If this is true of the economics of production, it is no less true of the economics of distribution—a subject which hitherto has made but little appeal to engineering recognition. Production is of no avail unless product and user be brought together.

Some thoughtful remarks on distribution were made at Boston last week by James H. McGraw, head of the McGraw-Hill Publishing Company, in acknowledging the award of the Harvard gold medal for distinguished contemporary service to advertising. Though made with specific reference to advertising, they have quite general application to distribution, of which advertising is a tool. Two phenomena were emphasized: *first*, the action of an effective distribution mechanism to lower the cost of interchange between maker and user; and *second*, the reciprocal effects of this same mechanism upon both user and maker. The latter particularly invites attention, because of its relation to the highly organized development of modern existence.

Production has progressed far from the primitive stage in which a clearly felt need and an independently developed ability to create products meeting that need came into chance conjunction. The world of today is too complex for this simple system. Neither the requirements of the user nor the productive possibilities of the maker are definitely articulate. They shape each other by mutual contact. The using world did not say, "We need the automobile," or the producing world say, "We are prepared to make automobiles," but both the desire to use and the ability to make were evolved gradually after the first awkward attempts to make and the first hesitant willingness to buy and use.

Mankind's desire and ability to consume, to utilize the output of production, are potentially unlimited. They are bounded only by productive capacity. And similarly its capacity to produce transcends by far that which has so far been realized; production is ready to undertake new types and grades of product whenever the wants of men require. Thus it comes about that both the power to produce and the readiness to use are waked to life mainly through the reaction of each upon the other. The maker produces that product and grade which the user demands; the user succeeds in applying that which the maker is able to produce. So a better product leads to a higher type of use, and the exigent demands of the user lead to a higher product.

But these reactions can proceed effectively only by aid of an efficient mechanism of distribution. That widely ramified network which connects maker with user is the instrument by which the adjustment of the two interests is brought about. Herein lies the creative function of the distribution mechanism.

To quote from the address mentioned, recalling again that while the speaker dealt with advertising his words are pertinent to distribution as a whole: "More and more, advertising becomes essential to the economical movement of goods. . . It shifts the competition to bases of quality and use. . . It reduces production cost by insistence, in the planning of campaigns, on conformity of goods to needs, and on standardization and simplification. It helps to stabilize industry. It emphasizes quality and use, which, with price, are sounder criteria of value than price alone. It assures, through stabilization, the continued improvement of products and the development of new products to minister to the consumer's needs."

Without further analysis it will be plain that services of large meaning to humankind are at issue in these relationships. They have already changed profoundly the arts of production—even that of making mousetraps—and will continue to change them still more. But not industry alone should give heed to these changes and study the science of distribution economics. Those who make industry possible, the community of engineers, have equal need of extending their thinking into this field.

Sixty-Three-Mile Railway Completed in Ten Months

Double-Track Line Connecting the Chesapeake & Ohio With the Hocking Valley Railway—Heavy Grading Resorted To in Order to Obtain Low Grades and Easy Curves

SPEED of construction was the governing factor in laying out the construction program for the new 63-mile double-track line that now connects the Chesapeake & Ohio Railway at Gregg, in Pike County, Ohio, with the Hocking Valley Railway at Valley Crossing near Columbus, Ohio. A protracted legal argument before the Interstate Commerce Commission over its approval of the project so delayed the start of work that when approval finally was granted, only ten months

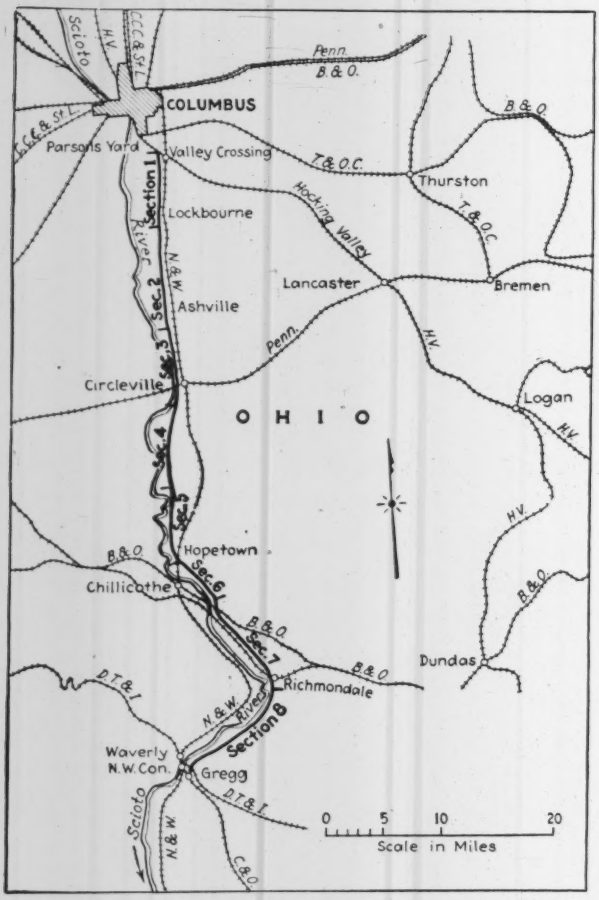


FIG. 1—NEW LINE OF THE CHESAPEAKE & HOCKING RAILWAY IN OHIO

remained before the agreement would expire by which the Chesapeake & Ohio freight moved over the Norfolk & Western tracks from the end of the C. & O. line at Waverly to Columbus. In that time it was necessary to move nearly 1,000,000 cu.yd. of rock and more than 4,000,000 cu.yd. of earth and to place about 10,000 tons of structural steel and more than 100,000 cu.yd. of concrete in bridges and highway crossings, also to lay and ballast 63 miles of double track. Contracts for the work were let on Nov. 17, 1926. The first train was run over the line on Aug. 23, 1927. By the time the trackage agreement with the Norfolk & Western expired in September, trains were operating regularly over the new line.

The new railway was built by the Chesapeake & Ohio, under the corporate name of the Chesapeake & Hocking Railway, to bring into existence a complete railway line from the coal-producing states of Kentucky and West Virginia to the Great Lakes at Toledo. Its construction completes the project, begun in 1915, of building a connecting line between the Chesapeake & Ohio at Scioto-ville on the Ohio River and the Hocking Valley at Columbus. Before the war the line was built as far as the Norfolk & Western junction at Waverly (*Engineering News*, Jan. 6, 1916, p. 6). Continuation of the line from Waverly to Columbus makes it possible to run solid trains of coal from the West Virginia coal fields to the Lakes at a high average speed without having to break them up for tonnage changes. It is estimated that the tonnage of coal originating along the Chesapeake & Ohio during the next five years will reach 60,000,000 tons annually, a large part of which will pass through the Columbus gateway.

Characteristics of the Line—The new railroad is double tracked for its entire length and has three center sidings, each capable of holding 125 cars. It is a low-grade line, matching northbound the Toledo division of the Hocking Valley, which is 0.2 per cent northbound and 0.5 per cent southbound, the loaded trains moving northbound. Trains of 8,100 tons are run northbound. There is one momentum grade at the connection between the old and the new lines near Gregg. The curvature is light, generally not more than 1 deg., the maximum being 3 deg., compensated.

All but one highway crossing and all railway crossings are at different levels. There are five railway and 42 highway crossings. A number of the latter were unusually costly to build, because in order to carry the highway over the new railway it also was necessary to carry it over an interurban electric railway that runs parallel to the new line for part of its length.

Stream crossings were not large, but were numerous, the total number of bridges being 56.

Construction Sections—For construction purposes the line was divided into eight sections, separate contracts being let for each section. Beginning at the north end, the country through which the line runs is rolling land, increasing in ruggedness as the south end is approached, there being little rock until the extreme south end of the line is reached. Section 1, at the north end of the line, is in a country that required very little cutting but a considerable amount of filling across low, wide valleys. The grade of the line in this section was fixed largely by the grade of the highways, elimination of all grade crossings being obligatory.

Material for the embankments was taken from borrow pits, chiefly from clay and gravel beds, which are charac-

FIG. 2—CHARACTERISTIC ROCK EXCAVATION, USING LARGE STEAM SHOVELS

teristic of the country, not a difficult operation except that, as the work was done in winter, wet weather made the clay sticky and hard to handle.

Section 2—The second section had many light cuts and low fills in material which differed from Section 1 in that it was entirely of clay. Slides were not uncommon in the fills during wet weather. On Section 1 the excavating work was handled chiefly with small shovel outfits, but on this section a great deal of the material was moved with teams, the contractors maintaining two team camps, containing about 200 head of stock.

Section 3—The cuts and fills on the third section were unusually long, one fill being 9,000 ft. long and 5 ft. high, another fill 6,000 ft. long and 30 ft. high at the maximum point, and one cut 6,000 ft. long and 25 ft. deep. Large steam shovels were used in the excavating work, dipper capacities running up to about 3 yd., and excavated material was moved in 20-yd. and 12-yd. air-dump cars on standard-gage track carried on temporary trestles over the fills. The record for material handling on this section was 3,500 cu.yd. in one ten-hour shift. A notable feature of the filling work was the use of unusually substantial trestling in order to avoid delays due to derailments and to movement of the trestle during filling. As a result the contractor did not have a single derailment or a car over the bank during the whole operation.

Section 4—Digging on the fourth section was still heavier, the cuts being deeper and the fills higher, with one unusually large side hill cut, which was taken out by making a series of cuts, using a 2-yd. shovel and narrow-gage cars. The best record on this work, which

FIG. 3—HEAVY WORK IN CLAY AND LOOSE ROCK

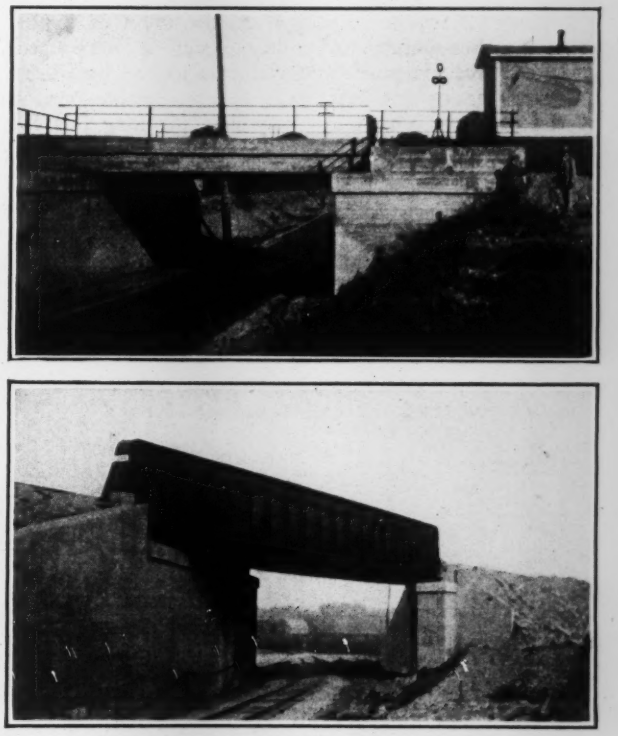


FIG. 4—TYPICAL BRIDGE WORK

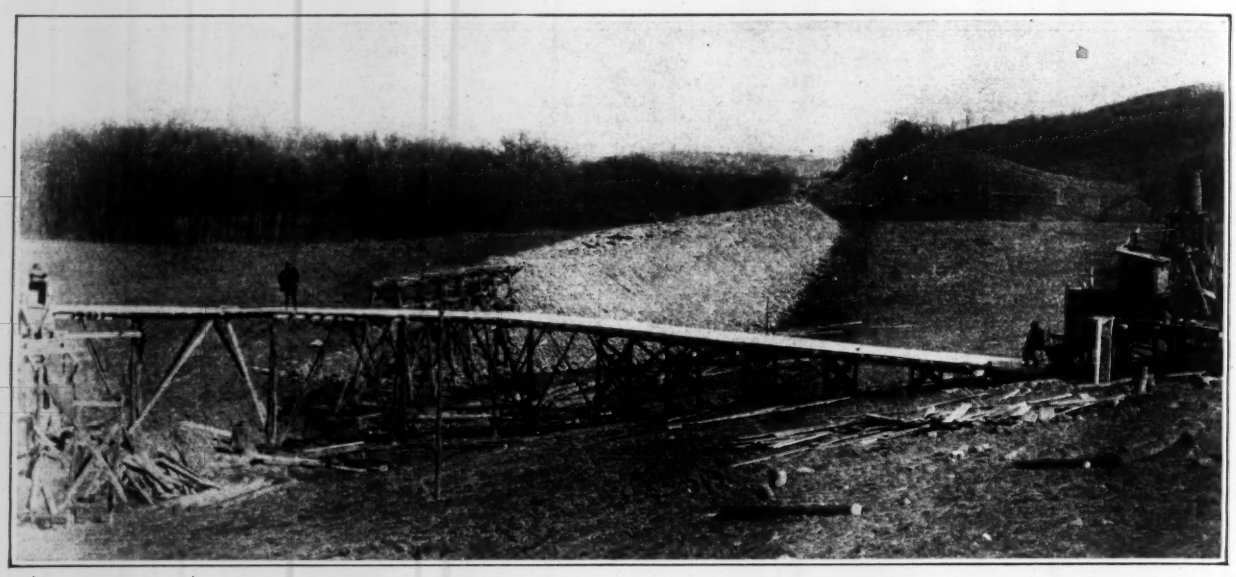


FIG. 5—CONCRETING PLANT FOR A HIGHWAY UNDERPASS

was in mixed clay and gravel, was 586 4-yd. cars in one nine-hour shift. The work included the diversion of Scippo Creek in order to eliminate two bridges.

Sections 5 and 6—One contractor handled both Sections 5 and 6. As in Section 4, the material handled from the cuts was largely clay and gravel, and the work was complicated by the large amount of rain that fell throughout the winter. A 40-ft. cut 3,600 ft. long through yellow and blue clay and cemented gravel was the toughest proposition in the grading work. It was taken out in benches, using a 2-yd. shovel served by three trains of twelve 4-yd. dump cars hauled by gasoline locomotives. The record on this cut was 398 4-yd. cars in one ten-hour shift. This was in hard digging.

In some heavy cutting opposite the town of Chillicothe two heavy-duty railroad-type shovels were used. On these sections much material was moved by teams, graders, wagons and tractors. A considerable portion of the earth moved in this way was for long fills for highway overcrossing.

Section 7—This section, except for some work at the south end, was perhaps the most level section on the entire line. The grading consisted in making long shallow fills and small cuts, most of the work being borrow excavation. For this reason numerous small grading outfits were used and many teams of horses or mules.

Section 8—Some of the heaviest digging on the whole line was encountered on the eighth section in the hill region at the south end of the line. Except for the top soil, which was clay, the cuts were in heavy gravel, shale and rock. The yardage moved here surpassed that moved on any section, amounting to 1,150,000 cu.yd.

Labor—Local labor was employed as much as possible. Its use not only reduced the number of camps and boarding cars but also provided a better class of workmen, as the majority of the men so employed were farmers or farm hands. These men were only too glad to get extra work during the winter season, some of them driving long distances in their own cars back and forth to work each day.

When the work was at its height, two shifts of men were used, the shifts working about eleven hours each.

FIG. 6—BUILDING ONE OF THE HIGH EMBANKMENTS

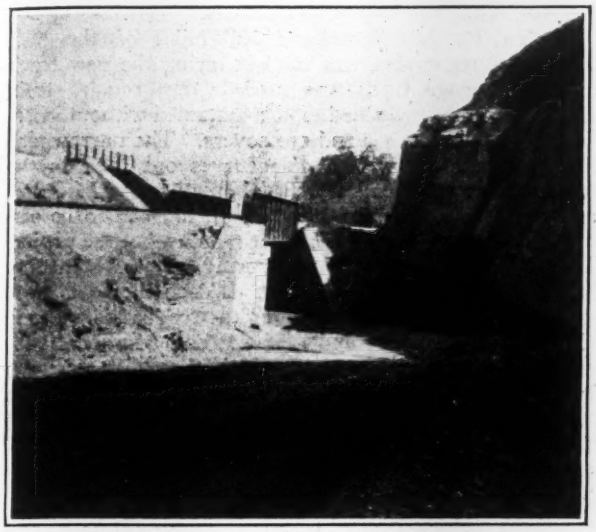


FIG. 7—SEPARATION OF RAILWAY AND HIGHWAY GRADES
Highway and D. T. & I. Railroad relocated for complete separation of grade. Railroad passes under the new line beyond the highway underpass.

Track Work—Tracklaying and ballasting were done by contract. The track was laid with 100-lb. rail on tie-plates punched for both 100-lb. and 130-lb. rail. This arrangement will make it possible to relay the track with 130-lb. rail when the present rails need renewing, without having to renew the plates, at the same time permitting the use of lighter rail during the construction period, when rail may become surface bent or otherwise damaged.

The preliminary ballasting was done with pit-run gravel from local pits. Final ballasting will be done with washed gravel. Ties are of hardwood, mostly oak, all ties except white oak being creosoted.

Bridge Work—Railroad bridges were designed for Coopers E-70 loading. Two types of decks were employed, open decks for stream crossings and ballasted decks for highway crossings. Typical examples are shown in Fig. 4. Concrete work for the bridges and culverts generally was sublet. For most of the structures the contractors set up mixing plants close to the work, but in one instance, where a considerable amount of concrete was required for jobs close together, concrete was distributed by truck from a central mixing plant.

In most instances cast-iron pipe was used for culverts under high fills, but in some locations concrete pipe, heavily reinforced, was used instead.

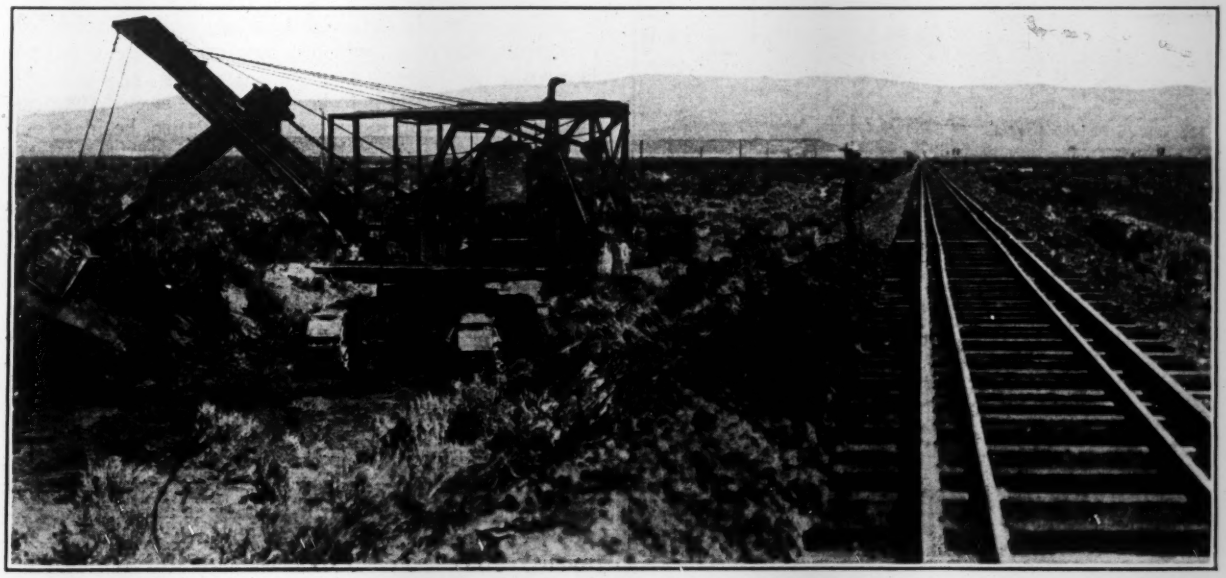
Engineers and Contractors—The work was in direct charge of W. Michel, chief engineer of the Chesapeake & Hocking, and C. A. Whipple, district engineer, with resident engineers on each section as follows: C. E. Butler, C. P. Essman, E. E. Nelson, J. S. Stevenson, W. H. Eary, T. S. Pattison, E. J. Jones and E. H. Adams. The contractors were the Fritz-Rumer-Cooke Company, the Ferguson-Edmondson Company, the Sturm & Dillard Company, the Dominion Construction Company, the Walsh Construction Company (Sections 5 and 6), the A. Guthrie Company, Inc., and the H. W. Nelson Company.

Broadgaging the N-C-O Railway

In Four Months 100 Miles of Wider Track Laid. Road, Organized in 1880, Now Controlled by Southern Pacific

A NEW LEASE of life has come to the Nevada-California-Oregon Railway as the result of broadgaging the line following the transfer of control to the Southern Pacific. The northeastern part of California, through which this line runs, has the climate and rainfall and fertility that make the territory highly productive, but development has been long held back because produce could not be shipped to distant markets without reloading. This handicap is being eliminated by connecting the line with the Southern Pacific system and broadgaging the track, which was about two-thirds completed in 1927 and will be finished early this year.

The N-C-O Railway had its beginning in 1880 as the Nevada & Oregon Railroad Company, formed to construct a line from Reno, Nev., to Beckwith Pass, Calif.



TYPICAL ROADBED WIDENING OPERATION ON THE N-C-O.

of the project and involving an outlay of $4,000,000, will be completed about July 1, 1928.

Causeway St., on which the new North Station will front for a distance of about 550 ft., is to be widened by a setback on Boston & Maine property to give a width of 116 ft. The total frontage of the combined group of railroad buildings on this street will be 700 ft. Additional street width is to be obtained by having the sidewalk on the station side cloistered within the building proper. Two overhead inclosed passageways with ramp approaches to and from the train concourse and waiting room will bridge the widened thoroughfare and connect the passenger terminal with the existing elevated railway station above the street.

The outstanding features of the new station will be its convenient arrangement and the separation of all baggage truck movement from pedestrian passageways on the track level. The station concourse, extending 512 ft. athwart the 23-track rail head, will be separated from the latter by ornamental grillwork and glass partitions. The waiting room will parallel the concourse for two-thirds of its length, with ticket offices, parcel checking rooms, telephones and news stands placed, for greater convenience of passengers, intermediate between them. Between the waiting room and Causeway St. a series of stores and shops will open upon both the street and the station floor.

By means of an overhead ramp arrangement for baggage handling, the 25,000,000 passengers using the station annually will be free from the inconvenience involved in baggage-truck movement across lines of pedestrian traffic.

The site of the terminal is on made land, but no difficulties are expected in preparing the foundations, which will be supported on concerte piles driven down 55 ft. into clay and gravel. There will be no basement in the station building, its waiting-room floor being designed to rest upon the ground.

The present track arrangement will continue unchanged, and upon removal of the old trainshed, which, as a part of the old station, now extends about 200 ft. over the tracks, the existing wooden umbrella shed beyond it will be extended to the line of the new station building. The latter will overhang the track a distance of about 30 ft. beyond the concourse fence with a sloping ceiling to allow engine smoke to rise. The pitch of this ceiling will correspond to the sloping floor of the coliseum above it. A horizontal false ceiling, slotted over the track centers, will prevent engine smoke from being blown down upon the track platforms and into the station.

The coliseum is expected to fill a long-felt want in Boston for a large convention hall where national conventions, trade expositions and other large gatherings can be accommodated on a scale comparable with those held in New York, Cleveland and Chicago. The coliseum will also serve as a sport arena for staging major sporting events. Its floor surface will be 250 ft. long and 125 ft. wide, and the maximum height to the vaulted roof will be 90 ft. Exclusive of the 18,500 seats on the main floor and two balconies, the hall will have an additional capacity of 15,000 on the pit floor for exhibitions which require only a limited space. The installation of ice-making equipment will make it possible to use the coliseum floor for a skating rink. The coliseum is to be leased by the railroad to an operating company.

Contract for the reconstruction work was let to Dwight P. Robinson & Company, New York, in November.

A French Three-Point Rail Joint and Frogless Frog

A RAIL JOINT with flat splice-bars or fishplates designed to transmit the load from a short contact-surface under the rail heads to two short contact surfaces on the rail flanges is in experimental use on the Southern Railway of France. It is known as the "chevron" joint, since theoretically the splices would be of inverted V-shape. This same railway is also using a turnout construction in which the ordinary frog is omitted. These devices have been described in the *Revue Generale des Chemins de Fer* by George Coullie and Louis Cadis, chief engineer and assistant engineer of maintenance of way of the railway. It is stated that, since the first trials proved satisfactory, more extensive trials are now being made.

FIG. 1—THE CHEVRON RAIL JOINT
Left, the principle of the chevron. Right, the splice plate based on this principle.

Rail Joint—In the design of the "chevron" joint, Fig. 1, the length of fishplates must be considerably less than the joint tie spacing. With joint tie spaced 16 in. c. to c., the flat fishplates are $8\frac{3}{4}$ in. long. These plates are crowned or cambered vertically so that the top has a horizontal contact surface at the middle, only $3\frac{1}{8}$ in. long, whereas the bottom has at each end a horizontal contact surface $1\frac{1}{2}$ in. long. There are only two bolts, and when these are screwed up tight they tend to raise the rail ends slightly.

In applying the joint, the spikes are removed from two ties under each rail, the splice plates and bolts are placed and the nuts are screwed on lightly. Then the joint is raised with crowbars about $\frac{3}{16}$ in., but never more than $\frac{1}{8}$ in., above the normal level of the rails, and the nuts are tightened thoroughly, working them alternately so as to get them uniformly tight without tilting the splice plates. Finally the spikes are redriven and the four joint ties are thoroughly tamped. Self-locking nuts are considered desirable. As the efficiency of the joint depends largely upon the tight grip of the bolts, these have to be inspected frequently during the first few weeks.

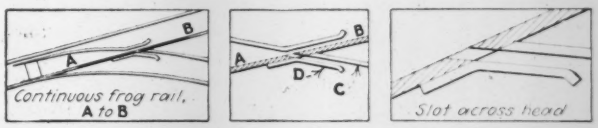


FIG. 2—CONTINUOUS-RAIL TURNOUT

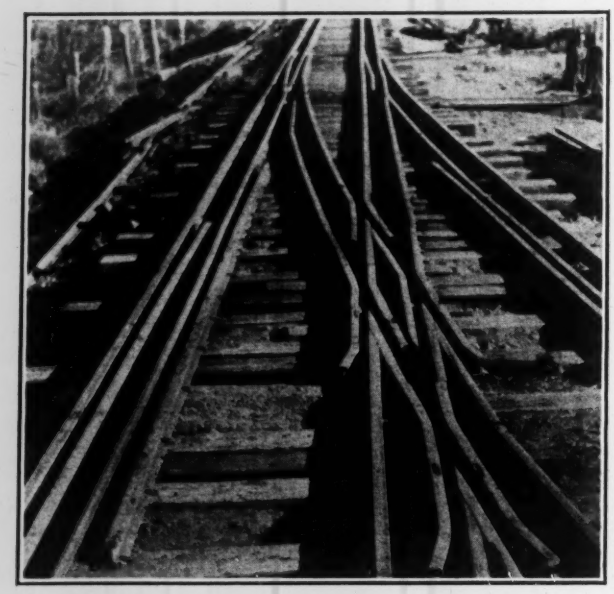
Frogless Turnout—In the turnout construction which eliminates the ordinary frog, as shown in Fig. 2, the lead rail in one track is unbroken from *A* to *B*, except for a slot across the head at the position of the frog point, to form a flangeway for wheels on the other track. To this rail are bolted the beveled rail, *C*, and the wing rail or guard rail, *D*, the latter forming also a relieving rail to engage the heads of wheels approaching the flangeway slot. One effect of this construction is to reduce the wear by which the level of the point of a rail-frog becomes lower than the lead rail, with consequent shock as each wheel passes.

This construction is reported as having given satisfac-

SKETCH SHOWING RELATION OF N-C-O TO SOUTHERN PACIFIC SYSTEM

This line was extended as finances permitted and in 1888 the N-C-O Railway Company was organized, naming The Dalles, Ore., as the objective for the ultimate terminus. In 1912 the track construction had been carried as far as Lakeview, Ore., and in 1917, 104 miles of the road, including the Reno terminal, was sold to the Western Pacific Railroad Company. Under an order of the Interstate Commerce Commission of May 3, 1926, the Southern Pacific acquired control of the 155.6 miles of the N-C-O from Wendel, which is on a branch of the Southern Pacific system, to Lakeview, Ore.

The work of standard gaging was begun during the summer of 1927, and in a period of four months, without interrupting regular service of either passenger or freight trains, the broadgage track had been laid by the Southern Pacific's forces on 100 miles of the line. Broadgage equipment was used in laying the new track and narrowgage track was used by the regular train service, so both tracks had to be maintained without interference at all switches and crossovers. The narrowgage line was laid out with simple curves only and in the broadgaging, easements were used on all curves of 3 deg. and over. The work of standard gaging had to be discontinued during the rainy winter months, but the project is to be completed early this spring, after which only standard-gage equipment will be used on the road.



TYPICAL SWITCH FOR DOUBLE-GAGE TRACK

In the work of standard gaging the roadbed is widened the necessary amount and new ties and additional rails are laid, using the same center line as the old narrowgage track. The old ties were 6 x 8 in. x 6 ft. and the new ties are 7 x 8 in. x 8 ft.

A large portion of the mileage on this road consists of low fills. Here the additional width of roadbed was provided by gasoline-driven power shovels mounted on crawlers. These shovels picked up material for widening the fill from a continuous borrow along the right-of-way, the power shovel operating on both sides of the track.

The work has been under the general direction of George W. Boschke, chief engineer of the Southern Pacific. A. E. McKennett, construction division engineer, directed the work in the field.

Rebuilding of North Station in Boston Under Way

Passenger Facilities to Be at Street Level—Arena and Coliseum to Be Included in the Terminal

PLANS for the reconstruction of North Station in Boston were announced by the Boston & Maine Railroad about the middle of November. The proposed work is part of a larger project for the modernization of the railroad's facilities in the northern part of the city which has been under way since 1926; also it will tie in with plans which the city has been making for improving and widening streets in the neighborhood. Additional details concerning the work, which is now under way, are given herewith.

The new terminal is to be built on the site of the present station and will include in its structure, besides completely modernized passenger station facilities, a large convention coliseum and arena. Future plans for the project include a hotel building to adjoin the station on the west, and on its eastern flank a fourteen-story building for offices and a distributing terminal. Work on the preliminary stages of construction was started in November. It is being carried on in such a way as to produce as little interference with existing facilities as is possible.

The lateral dimensions of the new station building, which will be of steel and concrete construction, about six stories in height, are indicated by the fact that its waiting room will have seats for 500 persons, two-thirds more than are provided in the Grand Central Terminal in New York. The coliseum will occupy the same space, in plan, as the waiting room, overlying it and a mezzanine floor, on which will be located the men's and women's rooms, barber shop and concessions. The station building and its passenger facilities, comprising the first unit

tion in service and as being of special advantage for turnouts at terminals where the turnout track is used only for switching movements and at low speeds. Its cost is much lower than for a frog of cast manganese-steel.

Economics of Treated Ties on the Lackawanna Railroad

Low Renewal Record Due to Careful Selection, Heavy Treatment, Large Tie-Plates and Screw Spikes

TIE RENEWALS have been reduced to less than 100 per mile per year for a succession of years on the Delaware, Lackawanna & Western Railroad. This exceptional record has attracted considerable notice. The practice and records of this road were described very fully at the annual meeting of the American Wood Preservers Association by George J. Ray, chief engineer of the railroad, in a paper which is abstracted below. It is of interest to note that the results are attributed to selecting good timber, cutting and boring it before treatment, treating it heavily with creosote and protecting the treated wood by means of screw-spikes and large tie-plates. —EDITOR.

THE Lackawanna Railroad started the use of treated bridge ties in 1905. Treated track ties of 7x9-in. sawed heart yellow pine placed in the trainshed at Hoboken in 1907 are still in service after twenty years and give every indication that they will last twenty years longer. But our bridge ties, especially on the main line, were destroyed by mechanical wear long before they showed signs of decay. They were not large enough, and the deeply flanged tie-plates did much toward their destruction. In 1909 we decided on the treatment of all ties and bridge timber, and since 1911 we have bored and adzed all ties before treating them.

Tie-Plates and Screw Spikes—After exhaustive study of means for protecting treated ties against mechanical wear, we adopted a flat-bottom tie-plate. The screw spike was in turn adopted, to give maximum holding power and reduce mechanical wear. Our standard tie-plate for the 130-lb. A.R.E.A. rail is $7\frac{1}{2}$x$12\frac{13}{16}$ in. and is $\frac{3}{4}$ in. thick at the center of the base, with a cant of 1 in 40. The rail rests in a groove and is held by one cut spike on each side, but the plate is fastened to the tie by two screw spikes independent of the rail fastening.

For our standard spike it was necessary to develop a template for testing the spikes purchased; otherwise we could not use a new spike in an old hole, as the least variation in pitch of thread would destroy the wood fiber and nullify the holding power of the spike. It was also found necessary to provide a spike with a pilot or unthreaded portion on the end, by means of which the spike can be driven into the hole sufficiently for the threads to catch. These spikes are driven by machine, especially in construction and heavy maintenance work.

Wood for Treatment—In 1910 it was generally considered unwise to treat white-oak ties, since they take very little creosote and without treatment give a reasonable life. But it seemed that as treatment so materially extends the life of inferior woods it ought to be valuable in extending the life of white oak. Experience has proved that this was a wise decision.

During the first few years we purchased a large number of sap pine ties, but they cut too rapidly on the curves, in spite of the heavy tie-plates and screw spikes used to protect them. However, treated sap pine ties placed in tangents during 1910, 1911 and 1912 are still in service, with a prospect of much longer life. From the start we have treated all switch timbers and bridge ties.

Tie Renewals—The average number of ties used per annum per mile of all tracks for the sixteen years 1900 to 1915, inclusive, was 238, giving an average tie life of 11.6 years. For the ten years 1918 to 1927, inclusive, the number was 120.4, giving an average life of 23 years. For the five years 1923 to 1927, inclusive, the average number was 94.5, giving an average life of 34 years. This remarkably low average during the past five years is due partly to the fact that the first treated ties placed have not yet reached their normal cycle. It is my belief that the number of ties for maintenance per mile per annum for the next two or three years will not exceed 100; it is probable that the number will then increase until a uniform rate is reached somewhere between 110 and 135.

We used an average of 619 sets of switch ties per year from 1910 to 1917 inclusive, but for the nine years 1918 to 1926, inclusive, the average was only 353 sets. Prior to 1910 most of our switch ties were longleaf yellow pine purchased in the South. Since we started to treat local hardwoods we have been able to secure all our switch timber along our line.

Conclusions—To summarize some of the gains accomplished due to the treatment of ties: (1) Utilization of woods which are practically useless for untreated ties, but which are available along our line; (2) reduction in total number of ties required, so that we now secure most of our ties along the railroad; (3) this reduced number is a great help in track maintenance, especially in times of labor shortage, as tie renewal is not the big job it used to be; (4) the use of good ties of uniform size, with uniform seasoning and treatment, has resulted in better and more uniform track; (5) with screw spikes and heavy tie-plates to prolong the life of the ties we have incidentally maintained stronger and better track.

Low Tie-Renewal Record—Many engineers do not understand how it has been possible to reduce annual renewals to less than 100 ties per mile of all tracks for a number of years in succession. Many roads using creosoted ties extensively do not have as good a record. There are three reasons for our showing: (1) Use of creosoting in an extensive way for both construction and maintenance work, and including white oak; (2) purchase of good, uniform ties and use of a heavy treatment of $3\frac{1}{2}$ gal. of creosote in each main track tie; (3) the use of big, flat-bottom tie-plates with screw spikes, and the boring and adzing of all ties before treatment.

Estimate of Financial Saving—While it is impossible to give accurate figures as to the money saved, an estimate of the final cost, including interest, of a creosoted tie placed in 1910 indicates that by 1930 we shall have saved 93c. on every treated main-track tie placed in 1910. At present prices this saving would be $1.26. During the first six years we used an average of more than 500,000 treated ties per annum, so that the actual saving has already amounted to a considerable figure.

SIXTH OF A SERIES OF ARTICLES

Today in the Mississippi Flood Area

Engineering and Human Conditions in the Basins and Along the Levees as an Engineer Sees Them

VI—The Cairo Problem and Its Proposed Solutions

By W. W. De Berard
Associate Editor, Engineering News-Record

PROBABLY NOWHERE ELSE up and down the Mississippi River does the engineer face a harder flood-control problem than at Cairo, Ill. It is hard, not so much from the hydraulic standpoint as from the political, and from the physical geography of the situation. By its very nature the Cairo problem involves all of the complex financial, physical and political aspects of Mississippi River flood control as a whole. It has been made the subject of special study as an example of the complexity of the problem at many another point. —EDITOR.

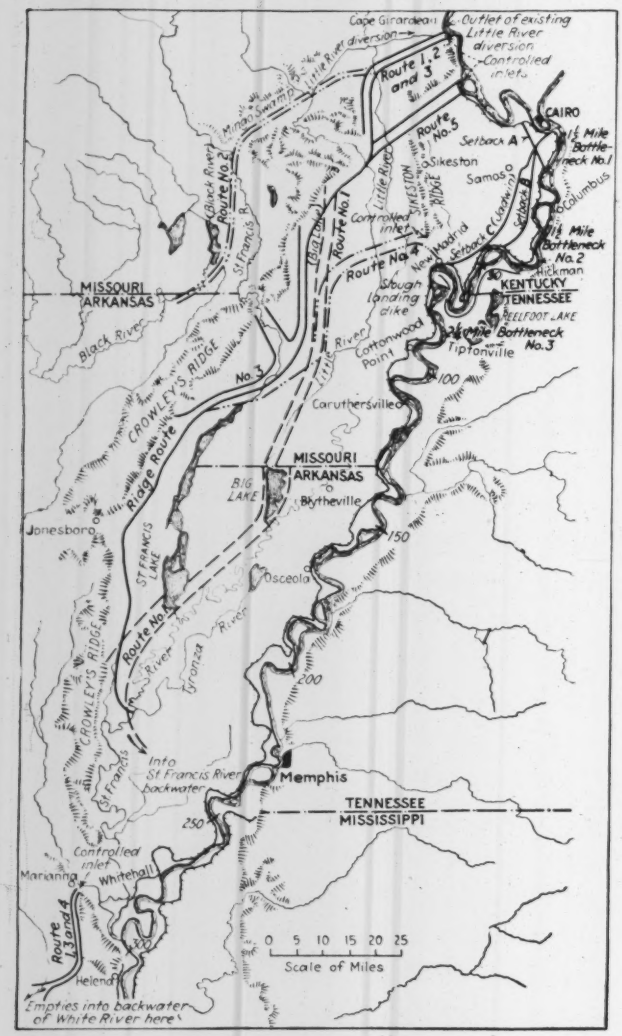
CAIRO, located at the extreme southern tip of Illinois, on a narrow flood plain between the Mississippi and Ohio rivers just at their junction, has long enjoyed the distinction of being a "breaking point" for freight rates in every direction, offering in consequence marked advantages for the location of industries. For an account of some of the city's features and municipal problems, the reader may refer to an article in *Engineering News-Record,* June 25, 1925, p. 1066. The population today is put at 16,000, about two-thirds whites. Within the levees is an area of 1,400 acres, with an assessed valuation of $6,360,000 and an actual valuation estimated by a banker-engineer at $36,000,000 (on the basis of $2,250 per capita, a figure usually used in checking up on school bonds). The Chamber of Commerce puts the figure at $50,000,000, of which $14,000,000 is for the 3,570 residences; $17,500,000 is for the industrial, commercial and utility investments; $6,300,000 is for retail and local business, and the rest for miscellaneous items including railroad property.

Four trunk-line railroads, river connections and the paved highway system of Illinois serve the transportation needs of commerce. In addition the city will soon be connected with the highway network of Missouri by a bridge under construction over the Mississippi. A similar connection over the Ohio to Kentucky is in process of financing.

The average ground elevation in Cairo is about 15 ft. and the lowest ground 27 ft. below the higher flood waters. The levees which encircle the city have their tops at a gage height of 60 ft., only 3½ ft. above the 1927 flood crest, which was materially cut down by crevasses. Had that flood been confined, the crest would have gone to 58.5 ft., it has been estimated. The maximum flow last year is placed at 1,800,000 sec.-ft., while the future "greatest" flow for which protection is being planned is set at 2,250,000 sec.-ft.—described as a *probable* flood maximum—which happens to be 25 per cent greater than the 1927 flood. This future flood, allowing 65,000 sec.-ft. increase of flow for each additional foot on the gage, would reach a gage height of 65.4 ft., which is *5.4 ft. above the tops of the present levees.*

Thus, Cairo is in a precarious condition. Although its levees have kept the town dry for 70 years, it has no

factor of safety against overtopping by floods that are quite likely to occur. Recent floods are generally conceded to have risen to higher crests because of floodway restrictions by levees and cutting off of former floodwater diversions. Levees in Missouri now prevent diversions and overbank flow down the Little River, St. Johns or St. James bayous. Levees built close to



PROPOSED FLOODWAY AND SETBACK LOCATIONS OF UPPER ST. FRANCIS BASIN TO WHITE RIVER

the low-water channel opposite Cairo at Bird's Point, south to New Madrid, have restricted the overbank flow of former years. Recently completed levees below Hickman on the Kentucky side prevent water passing south overland through Reelfoot Lake and the Scatters.

Remedies Possible

Three things can be done for Cairo: (1) Enlarge and raise its present levees; (2) raise its whole area; or, (3) lower the future flood plane. To every plan there is strenuous objection, backed in each case by able engineering opinion.

Levee enlargement with a crest rise of 10 ft. has been estimated to cost $6,000,000. Raising the whole city above flood elevations would cost $30,715,000. Lowering the flood level, under the cheapest of the plans proposed —a floodway approximately 5 miles wide back of the present levees—would cost at least $13,130,000. The Chief of Engineers' plan enlarged and lengthened this minimum floodway, which took in 53,000 acres, to take in 100,000 acres, but total costs are not available. This was to insure safety by lowering the flood plane still farther.

Danger of Levee Enlargement

Levee Enlargement—Although the levee-raising plan appears to be the cheapest of the proposals, it has a fatal weakness if it alone were depended upon. Cairo is underlain by gravel directly connected to the river. Alarming seepage and sand boils occur during every flood at the break between the ridges and valleys of the city's topography. These valleys and ridges, the products of alternate deposition and subsequent cut-backs of prehistoric days, extend across the city from levee to levee.

George F. Dewey, veteran city engineer, has the following to say with reference to the situation: "Levees are as high now as the town's engineering structures can stand during high water. Sewers cave in from sand leaching into them and leaving cavities, carrying the street pavement and other utilities into the same hole. Wells spout sand, and each one is a potential danger point, since it is almost impossible to seal the casing to the surrounding material. During the 1927 flood a well in an old brewery building nearly caused the structure to fall into the cavity formed; a seal was finally effected by pumping grout into the material around the casing.

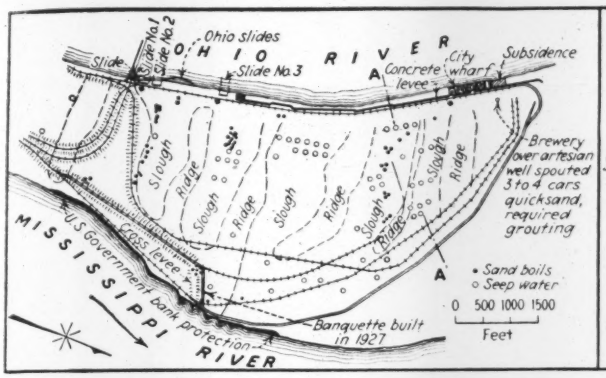
"A remnant of wooded swamp is usually found at the break between ridge and valleys. Old stumps and cypress knees rotting away finally leave an open passage for the water and sand to come to the surface. Removal of old stumps is, therefore, a municipal duty, and periodical inspections are carried out on private as well as public property. The stumps are dug out, roots are removed, and the excavation is backfilled with well-mulched material. During flood heights small trees that whip around in the wind loosen the material around their roots and start boils. Levee sloughs have occurred in several places from seeps and boils producing cavities under them."

Mr. Dewey's conclusion is that a limit has been reached in levee height without filling. This is backed up by an exhaustive study and report on Cairo's flood and drainage problems in 1922 by C. E. Smith. The latter states that "about the only successful way to prevent sand boils and seep water is (1) to increase the depth of fill over the affected areas so that greater resistance will be offered to the rise of groundwater, and (2) to increase the amount of pumping so as to lower the groundwater level.

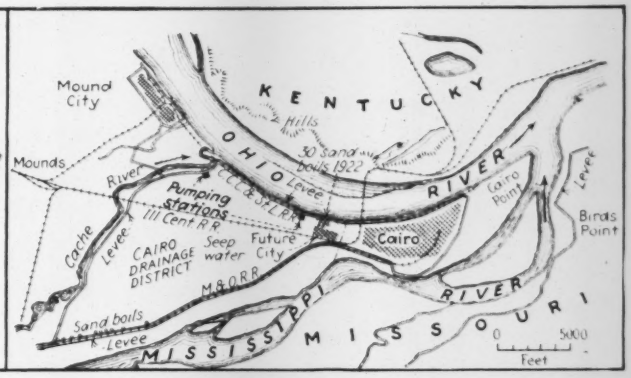
This brings us then to a consideration of the raising program. It may not be amiss to say that construction of higher levees without filling would tend to depopulate the town. Fear is justified, for a levee break would likely cause serious loss of life, and certainly would entail heavy property damage.

Filling Up Cairo—An estimate of the cost of raising the city to 69.6 on the Cairo gage, which is 9.6 ft. above the present top of the levees and 4.2 ft. above the crest of the "probable" 2,250,000-sec.-ft. flood, includes the following items:

Filling, 57,000,000 cu.yd. at 25c	$14,250,000
Street improvements	1,015,000
Sewers	750,000
Building and improvement changes	14,700,000
Total	**$30,715,000**



SAND BOILS OCCUR AT BREAK BETWEEN RIDGES AND VALLEYS



CAIRO IS LOCATED AT JUNCTION OF MISSISSIPPI AND OHIO WITHIN LEVEES

These figures include replacing all of the 23 miles of improved streets, 2 miles of alleys and 40 miles of sidewalks. The maximum depth of fill would be 27 ft. A complete new sewer system is contemplated. It was estimated that readjustment of buildings to the new grades would cost two-thirds of the valuation of the business blocks and factories, one-third of the valuation of the residences and one-quarter of the cost of the railroad and other corporation property. Obviously, for a city with property values of from $36,000,000 to $50,000,000 to spend $30,000,000 to raise itself is hardly possible as a matter of economic feasibility.

In his report Mr. Smith stated that to raise the city to a level with the tops of the levees (60 ft.) was unwarranted. He recommended, as a minimum, filling to established street grades, and as a maximum, filling to 3 ft. above these grades, except railroad and industrial areas, which he held it would be desirable to fill to levee height. His minimum fill required 3,150,000 cu.yd. for the city proper and 1,250,000 cu.yd. for the drainage district. The railroad and industrial property would require an additional 5,800,000 cu.yd. He placed the cost at $1,000,000 for the city and $850,000 for the railroad lands, amounts he believed the city itself could raise by bonds and special assessments.

Partial filling and partial raising of levees for Cairo would seem to be worth investigating. But once the pavements and utilities are covered with fill, and buildings must be raised, the additional cost of filling all the way to the new levee top would be practically only the extra cost of filling, or, roughly, $500,000 per foot elevation. Thus, the low-fill plan could cut $5,000,000 to $10,000,000 from the $30,000,000 estimate, which would still leave an excessive figure.

All of these calculations are based on raising the levees to 69.6 ft., to keep out the maximum probable flood with a 4.2-ft. freeboard. An estimate of $3,070,000 has been made to raise the levees 6 ft. only, to 66 ft., which presupposes some means of lowering the flood plane.

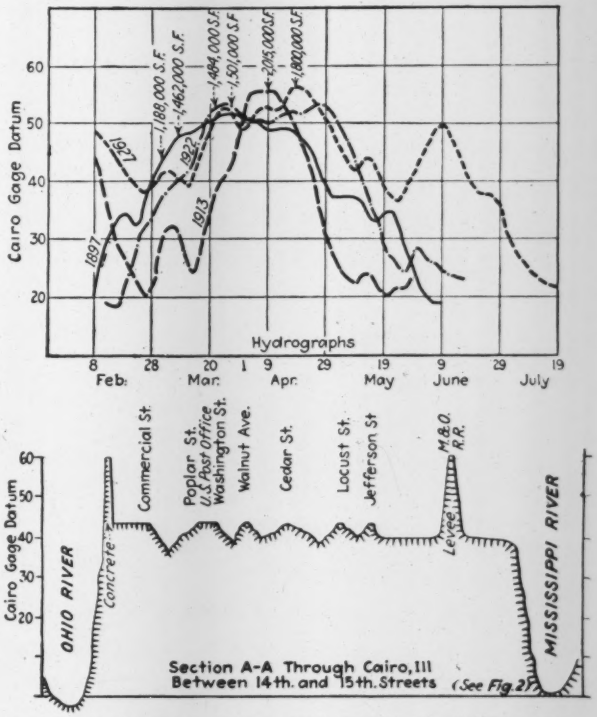
Lowering the Flood Plane—Three means are available for lowering the crests of future floods in the vicinity of Cairo: (1) Diversion channels, (2) levee set-backs and (3) impounding reservoirs.

Five diversion channel routes were investigated by the Diversion Board. Estimates have been made for diverting 500,000 and 300,000 sec.-ft. Since 300,000 sec.-ft. is about one-third of the flood volume of the Mississippi above Cairo, it is thought greater diversions would probably change the regimen of the river so adversely as to overbalance the good. Nevertheless, two routes on the 500,000-sec.-ft. basis were estimated.

Route 1 diverts the water just below Cape Girardeau through the St. Francis River across the lower portion of Crowleys Ridge to the backwaters of the Mississippi in the lower White River. The cost is $631,000,000.

Route 2 begins the same as Route 1, but follows a southwesterly course, over a supposed prehistoric route of the Mississippi, through Mingo Swamp and across the upper St. Francis River to Black River, thence down to the White River. The cost is $1,036,000,000.

Routes 3, 4 and 5 following are for diversions of 300,000-sec.-ft. capacity. Route 3, practically the same as Route 1 except that it is adjacent to Crowleys Ridge, costs $337,600,000. Route 4 begins in the backwaters of the Mississippi north of New Madrid, and thence follows a westerly course connecting with Route 3, with



GREAT FLOODS WITH RELATION TO CAIRO, ITS LEVEE, STREET AND LOT ELEVATIONS

HIGHEST GAGE HEIGHT EVER REACHED IN CAIRO, 56.4 FT.

Had the Dorena crevasse not occurred the water would have risen to 58.5 ft. A 2,250,000 sec.-ft. flood would raise the height (if confined within levees) to 65.4 ft.

which it then coincides; it would cost $309,300,000. Route 5 begins at Commerce and follows a westerly course to Route 3. Its cost is $323,000,000. Each of the last three routes will cost $83,600,000 less if ended in the backwaters of the St. Francis.

A 300,000-sec.-ft. diversion is estimated to lower a 2,250,000-sec.-ft. flood at Cairo by 4.3 ft., thus still overtopping Cairo's present levees by 1 ft. In addition, since all of these diversions cost so much, they have not been considered feasible. Levee setbacks to permit a more extended overbank flow and to remove bottleneck restrictions were next considered.

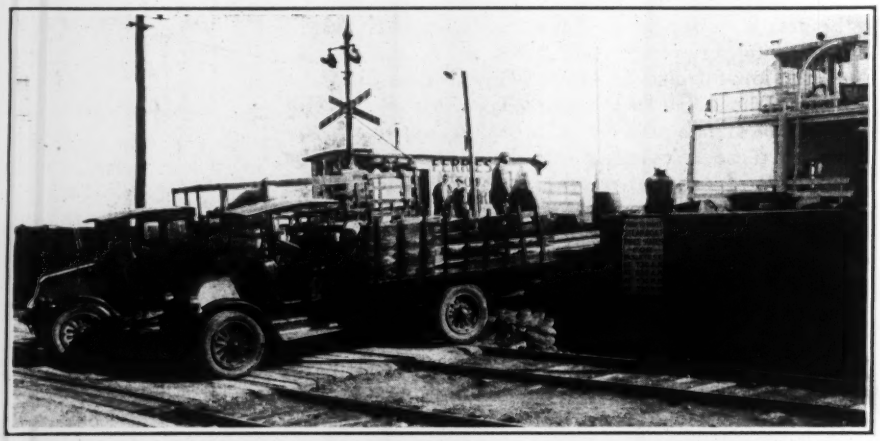
Levee Setbacks—Cairo engineers and officials have consistently contended for lowered flood planes. Even with filling they do not want to raise their levees. They have presented arguments and maps which show bottlenecks below the city that should never have been built, they hold, and now should be removed.

Priority of levee construction and occupation of low land on one side of the river is no barrier to the construction of levees at all or higher levees on the opposite side of a river. This question has been adjudicated in the $1,000,000 case of Memphis property holders suing the levee district on the Arkansas side. The Supreme Court has held that to prevent throwing up of levees would be prejudicial to the public good and stop all progress. So levees have been built on the Missouri side close to the river, and if they elevate the flood stages no action can be taken by Cairo. It is true that the Mississippi River Commission is continually making minor relocation of levees landward from their present sites at various points, but this work is not so extensive as to give Cairo a measurably reduced flood crest.

A setback 10½ miles long, beginning at Bird's Point, opposite Cairo, including an area of 30 square miles, was first studied. Backwater curves computed for flow rates of 1,800,000 and 2,500,000 sec.-ft. gave 1.9 and 2.4 ft., respectively, as the amount by which gage heights at Cairo would be lowered (Kutter's n assumed at 0.040, since the land was supposed to be cleared). This is hardly enough drop to make the enterprise worth while.

The next tentative setback begins at Bird's Point just below the Cotton Belt Railroad and the present levee, runs parallel to the railroad for 4 miles, thence southerly to the high ground near the southern end of James Bayou, thence curving to the right to the present levee 10 miles below Hickman. It is 29 miles long, against a river length of 47½ miles, and includes an additional flowage of 83 square miles. Computations for backwater curve for a 2,250,000-sec.-ft. flood gave a reduction of from 4 to 5 ft. in the flood plane, or a Cairo gage reading of 61.5 to 60.5. The bank overflow capacity was estimated by using 0.080 as Kutter's n, since it was not intended to maintain a cleared area. The cost was based on 83 square miles of land at $70 per acre ($3,710,000), and 23,550,000 cu.yd. in the levee at 40c. per yard ($9,420,000), or $13,130,000 total.

The floodway adopted by the Chief of Engineers widens and extends this tentative floodway to provide a lowering of at least 6 ft. on the Cairo gage. It is an average of 5 miles wide and extends to New Madrid. Land costs are not given in the report, since local interests were assumed to pay for them. They have been estimated by L. T. Berthe, consulting engineer for the Upper St. Francis Levee Districts, at about $18,000,000. This is on the basis of 135 square miles of farm land at $224 per acre less 20 per cent for residue, and 90 square miles of timbered and swamp land at $56 less 20 per cent



COMMERCE, MOSTLY INDUCED BY FLOOD ACTIVITIES, WAS CONTINUED BY THE FERRY BOATS TO MISSOURI

Sand bags were piled around the stop planks in the sea wall openings and material transferred directly from truck to steamer.

for residue. Based on M.R.C. estimates there is needed a total of only 156 square miles, of which only 78 square miles is under cultivation.

As noted previously, costs have been figured by M.R.C. engineers at $70 per acre regardless of development, making a total land cost for the setback of the Chief of Engineers of about $7,000,000, and $7,000,000 for the levee. Mr. Berthe estimates that an additional $1,500,000 should be allowed for rectification of drainage systems cut by the new system.

As to land costs, it is significant that most of the levee officials interviewed offered little objection to any setback anywhere if the government would pay all the costs. If condemnation could be assured on the basis of assessed valuation, as is done in Louisiana, it would materially expedite and simplify proceedings, as well as

SEEPS AND SAND BOILS CALLED FOR LONG STRETCHES OF SAND BLANKETING

Boils were serious around outhouses and following up roots of small trees which were finally trimmed to prevent wind from whipping them around and working roots loose.

reduce costs to figures where out-of-the-valley Congressmen could look on the assumption of land costs with less feeling of pork-barrel apprehension.

Investigations of the number of people, ownership, etc., in the Bird's Point-New Madrid floodway indicate that there are no towns of more than 100 population. About 3,000 people live in the area, of which 2,100 are whites. Most of the farmers are tenants.

Reservoirs—Impounding reservoirs in the St. Francis Basin and reservoirs on tributary streams above Cairo were studied carefully. All of them proved inordinately expensive.

Financial Angles

Since all engineering ultimately resolves itself into economical costs consistent with the end to be obtained in a practical way engineers cannot ignore costs and cost apportionment, as so many Washington statesmen think and state. Pure engineering might perhaps demand a uniform low-water channel and uniform high-water floodway regardless of obstacles, but the real engineer is nothing if not practical, and he must consider legal, financial and political aspects as well as geographical and physical conditions.

In the Cairo situation the floodway is designed primarily for protection of human life, but that protection is provided in another state, which state is asked to pay a substantial portion of the cost and in addition donate a right-of-way over much of the land which would be taxed to pay those costs. Illinois will get benefits for which Missouri is to contribute. As a whole Missouri cannot easily be interested, neither can Illinois be greatly interested to appropriate money to be spent in Missouri. It is probably easier to interest Washington than either Springfield or Jefferson City, though in the abstract it is not easy to see why California and Maine should be easier to persuade to contribute than those states within the boundaries of which accrue the major benefits of continuity of commerce, life and property protection and land reclamation.

The engineer must consider these questions. It is useless to evolve engineering plans that cannot be legally or politically or financially carried out. Elimination of these problems and simplification of administration are considered basic arguments for setting up a "government pay all" policy. No difficulties then would arise over cost apportionment between those benefited and those damaged. On the other hand, the fact that the legal and financial problems are difficult and not easy of equitable settlement is no more reason for taking that course than for proposing an ideal solution whose cost is prohibitive, whose legal status is folly, and whose administration is impossible.

A Brief Summary

Returning to the Cairo problem: We find the proposal to raise the levee the cheapest way out, but it does not surely protect human life—and that after all is the first consideration.

Raising the city the full height to the future flood crest would cost nearly as much as the entire present valuation, which eliminates that proposal, at least for the present.

Diversions run to the hundreds of millions, but setbacks are in the tens of millions.

The Mississippi River Commission wanted to study the Cairo situation more in detail, but the Chief of Engineers proposed a setback program he felt sure would work. It has brought more criticism than any other engineering feature of the program. Further refinements of his plan are desirable, and will be made before execution is begun.

Without question enough information and study are available to eliminate the proposals already rejected; not, however, to make a final decision for one plan. Under any circumstance Cairo needs to be filled at least to street grade, perhaps higher; reappraisal of the Smith report and additional estimates on filling to various elevations are required. This work can be charged to the city itself. Cost estimates of raising levees coincident with these successive ground elevations need to be made. This levee

SAND BOIL ON RESIDENCE PROPERTY NOT BROUGHT UP TO STANDARD GRADE

cost can probably be charged largely to agencies outside of Cairo—that is, to state or federal government. Finally, closer calculations based on topographical and economic surveys of possible floodways must be made. Flooding out 3,000 people in Missouri once in ten years to save the 16,000 citizens of Cairo needs a carefully prepared balance sheet of all the factors involved before it can be indorsed as a sound procedure.

Finally, one cannot study the Cairo-New Madrid situation without decided feelings of admiration for the analysis of the engineering proposals that have been made, nor without assurance that the best solutions have been arrived at consistent with the data at hand.

Responsibility for the study in the field of the Cairo situation rests on the First and Second Districts office, Mississippi River Commission, Memphis, of which Maj. Donald H. Connolly, Corps of Engineers, U. S. Army, is district engineer in charge. Directly assigned to this study were Maj. L. D. Worsham, Corps of Engineers, U. S. Army, and several civilian engineers, including R. W. Gay, E. C. Williamson, Henry Bloompot, G. L. Perry, Byron Bird and Blair A. Ross.

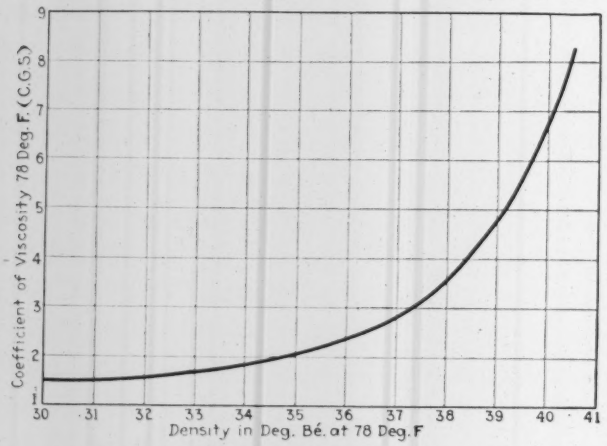
Consistency of Silicate of Soda for Curing Concrete

By Robert S. Beightler
Chief Engineer Bureau of Construction, State Department of Highways and Public Works, Columbus, Ohio

During the construction of a concrete experimental road in Ohio in 1927, on which several methods of curing were used, tests were made to determine the density at which silicate of soda should be applied and the proper time to apply it in order to secure the best results in curing.

Silicate of soda applied to green concrete at various intervals of time after it is laid possesses different spreading power, depending upon the amount of water in the surface of the green concrete. This surface water effects further dilution during application, reducing the density of the solution and decreasing its viscosity. These changes in physical properties of the solution increase its spreading power, with the result that either a given quantity is spread over too great an area, or, if permitted to remain on a smaller area, the solution will run off onto the shoulders due to the crown of the road.

The Ohio specifications require the application of 1 lb. of silicate of soda, as supplied to the contractors, diluted

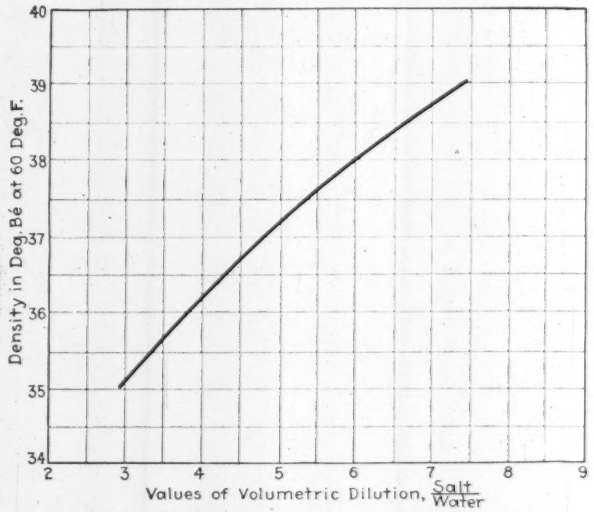


RELATION BETWEEN VISCOSITY AND DENSITY

three parts of the salt to one part of water by volume, to 1 sq.yd. of concrete surface. This dilution, with the silicate that was used on the Ohio project, produced a solution having a density of approximately 35 deg. Bé. at 60 deg. F. As supplied, the silicate had the following properties:

Density at 60 deg. F	42.6 deg. Beé.
Ratio Na_2O to SiO_2	1 to 3.25

On the basis of applying silicate of soda solution at a definite density, rather than by the less accurate method of dilution by volume, a number of tests were made on



RELATION BETWEEN DILUTION RATIO AND DENSITY

the Ohio experimental road construction to ascertain the correct density at which silicate should be applied to produce a more effective seal, using approximately 1 lb. of the silicate, as shipped, per square yard of surface.

In the first series the concrete was covered with wet burlap as soon as it had set sufficiently to prevent marking. The burlap was kept wet by sprinkling with a spray nozzle until the following morning, when the silicate was applied. The density of the silicate solution as applied to the different sections of concrete in this series of tests ranged from 35 to 37 deg. Bé. inclusive. Silicate diluted to 35 deg. Bé. and spread evenly over green concrete so as to give no loss on the shoulders required only 0.77 lb. of the original silicate of soda per square yard of surface. This dilution did not effect as complete a seal of the surface as a 36-deg. or 37-deg. Bé. solution, which required 0.90 and 0.96 lb. of the original silicate respectively.

In the second series of tests the concrete was covered as in the first series, but not sprinkled. As soon as the concrete had set sufficiently to bear the weight of a man without marking, the burlap was removed and the silicate solution was brushed over the surface with a soft hair push broom. The density of the silicate of soda in this series ranged from 37 deg. to 42.6 deg. Bé. inclusive, this latter application being the silicate of soda as supplied to the contractors on this road. In all instances the silicate was further diluted by the water in the surface of the concrete. This dilution caused considerable loss of silicate on the shoulders and a visibly less effective seal.

These results indicate that a more effective seal can be had with the same amount of silicate of soda by properly protecting the concrete until the day following its laying. The silicate then should be applied at a definite gravity of between 36 deg. and 37 deg. Bé.

Large Terminal Yard and Transfer Station

Chicago & Northwestern Railway L-Shaped Yard Outside Chicago Serves Three Main Lines—L.C.L. Transfer 1,426x626 Ft.—Flat and Gravity Switching

AN OUTLYING YARD of unusual shape and layout, with two switching humps and with the largest l.c.l. freight transfer station ever built, constitutes the new Chicago freight terminal of the Chicago & Northwestern Railway. This yard, located at Proviso, Ill., about 12 miles west of the company's city passenger terminal, covers about 1,500 acres and is L-shaped in plan, with a length of about 5 miles between yard entrances and at present about 250 miles of track. It is the destination and starting point of all road freight trains. Movements further east are either for local transfer between this yard and the company's city freight houses or for interchange of through cars with other railroads.

A special feature of this terminal yard, as shown by the sketch map, Fig. 1, is that it serves three main lines: one westward to Omaha and two northward by way of Madison and Milwaukee to Duluth, St. Paul and the Dakotas. In this way all road freight service is removed from the congested Chicago district to a large yard of modern design and equipment. At the east end of the yard are connections with the Indiana Harbor Belt Railroad, which gives direct communication with the Chicago freight yards of several other trunk lines for interchange service.

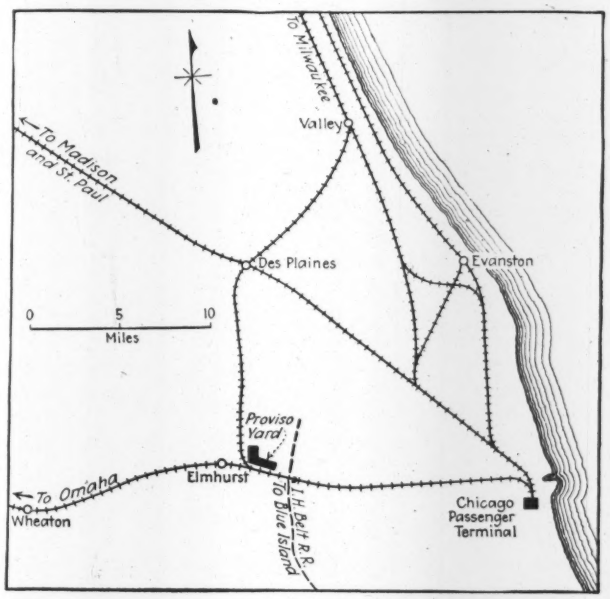


FIG. 1—CHICAGO LINES OF CHICAGO & NORTHWESTERN RAILWAY

Developments at Proviso—A freight yard was first established at this point in 1904 to handle overflow of local business for the Galena division (a part of the Chicago-Omaha line) and to provide connection with the Indiana Harbor Belt Railroad for interchange service. In 1910-1911 a line was built from the west end of the yard northward to connect at Des Plaines with the main line to Minnesota and the Northwest, and at Valley with the main line to Wisconsin and Michigan points. An engine terminal with 58-stall roundhouse was built in 1912. The main tracks of the Chicago-Omaha line were then at the middle of the yard site, with the switching facilities on the north side and car-repair tracks on the south. Additional tracks and improvements on the 900-acre site were provided gradually until 1922, when the establishment of a great terminal yard was proposed.

At that time the president of the railroad, the late William H. Finley, appointed a committee representing the engineering, operating and traffic departments to study the freight situation at Chicago and to develop a scheme for a comprehensive terminal yard at Proviso. To carry out the design proposed by the committee in 1924, about 600 acres of land were acquired for a northern extension and the main tracks were shifted to pass around the south side of the yard. Two bridges with steel spans and trestle approaches were extended to carry important highways across the entire area. A third main track was also constructed from the yard as far as West Chicago, 20 miles west of the yard, the middle track being signaled for operation in both directions. These various improvements were completed in 1925.

Further extensive developments, begun in 1926 and completed in 1927, include the following: (1) A 30-track yard on the connecting line to the north; (2) a large freight transfer station; (3) a freight record and office building; (4) grade separation at Lake St. and North Ave.; (5) and a receiving yard, with repair tracks, adjacent to the Omaha line, for the Indiana Harbor Belt Railroad transfer. A plan of the present layout of the terminal is shown in Fig. 2, with the large inbound classification yard which is now being built.

As the site is flat and swampy, a great amount of filling had to be done, using sand and steel-mill slag, the sand being covered with a bed of cinders as protection from the wind and as a surface for the gravel ballast. As the Belt Line is on an embankment and crosses over the Chicago & Northwestern Railway, the new yard connections at the east end are on long fills, with grades of about 0.5 per cent and curves of 6½ deg. Tracks are laid with 100-lb. rails on creosoted ties in gravel ballast. Turnouts have No. 8 frogs and 16½-ft. switch rails. Body tracks are spaced 13½ ft. c. to c.

North Yard—This new 30-track yard is north of Lake St. and parallel with the freight connecting line. Each track is long enough to hold 100 cars. Adjacent to it is a car-repair yard of seven tracks, spaced alternately 18 and 22 ft. c. to c. and having a capacity of 250 cars. This latter yard has a blacksmith shop, wood-working mill, storehouse, lumber shed and an air-compressor plant which serves the freight yard piping system for testing the brakes on cars. There is also a 75,000-gal. elevated tank supplied from a well 2,100 ft. deep by an electrically operated pump.

At present this north yard is used as a receiving and departure yard for trains of the two northern main lines. But in the final development it will be enlarged to provide receiving and departure yards for all three main lines, as noted later, the east yard then serving for city and interchange facilities.

As the tracks entering the south end of this yard cross two busy highways, the tracks were elevated and roads

depressed for subways with 14-ft. clear headroom. Both have through plate-girder spans on creosoted pile piers which will be replaced eventually with concrete structures. The North Ave. subway has two spans, each covering a 44-ft. roadway and 8-ft. sidewalk. The Lake St. subway has one span of 66 ft. and one of 14 ft.

East Yard—The present layout includes seven groups or yards, as shown in Table I. A classification yard

TABLE I—CAR CAPACITY OF YARDS

	No. of Tracks	Cars Per Track	Total Cars
No. 1—Serving l.c.l. freighthouse	17	70	1,190
No. 2—Bad order and condemned cars	17	60	1,020
No. 3—Wisconsin Division departure and hold yard	21	60	1,260
No. 4—Galena division departure	18	80	1,440
No. 5—I. H. B. R.R. receiving	10	100	1,000
No. 6—Wisconsin Division departure	20	90	1,800
Car repair	14	35	490
Total	117	...	8,200

with switching hump for inbound cars is now being built, north of the transfer station (see Fig. 2). This will have 52 tracks for 55 cars per track, or a total of 2,860 cars. Flat switching has been employed thus far, but this one hump will provide for classifying inbound local and interchange cars according to destination.

Adjacent to the car-repair yard is a row of buildings about 32 ft. wide, providing for a wood-working mill, blacksmith shop, machine shop, air-brake shop, paint shop, storerooms, oil and waste storage, storekeeper's office, car department office, locker and mess rooms and other facilities for the car-repair forces. These buildings are of concrete blocks with concrete floors and wood roofs, the interior height being about 10 ft. at the sides and 11½ ft. in the middle. Some of the buildings are only 30 to 50 ft. long; others are 160 to 240 ft. long, subdivided by partitions. The repair yard has tracks spaced 18 and 22 ft. c. to c., with paved roadways between them for handling materials by means of gasoline tractors.

Hump Profile—From a level stretch of track the approach to the hump, Fig. 3, rises on a short easy grade of 0.5 per cent for 100 ft. to the summit, which consists of three successive ascending grades of 2.5, 2 and 1.5 per cent, each 10 ft. long, followed by three corresponding descending grades of 1.5, 2 and 2.5 per cent, of the same lengths. Beyond the 2.5 per cent grade is the accelerating grade of 4 per cent for about 160 ft., followed by 1.2 per cent for 230 ft., 3 per cent for 100 ft., and 1.95 per cent for 280 ft. A bottom grade of 0.8 per cent for 80 ft. runs into a grade of 0.3 per cent extending along the ladder track and into the classification tracks.

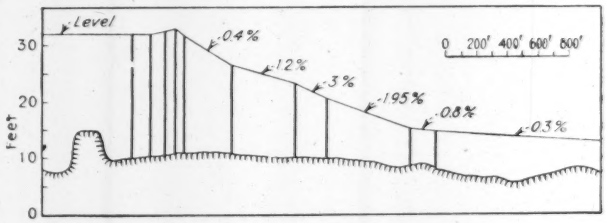


FIG. 3—PROFILE OF SWITCHING HUMP

Terminal Handling of Freight—The committee on transportation appointed by Mr. Finley, as noted previously, consisted of J. A. Peabody, signal engineer (chairman); H. W. Beyers, freight traffic manager, and H. M. Eicholtz, assistant general manager. After a thorough study of the company's Chicago freight terminal service, the committee's report, made in 1924, proposed: (1) The establishment of a large terminal yard and l.c.l. transfer station at Proviso; (2) abandoning the city yard at State St. and Grand Ave.; (3) closing three Chicago transfer stations at Fortieth St., Sixteenth St. and Wood St., and also the one at West Chicago (30 miles out); (4) constructing a new city freight station at Wells St. and the river.

This last station, which will occupy the site of the old passenger terminal, will have truck driveways at the street or viaduct level, with tracks below. Arrangements have been made for the construction of a ten-story dry-goods warehouse utilizing the air-right space above the station. At this point also there is connection with the 65-mile underground electric freight railway system of the Chicago Tunnel Company for local distribution and collection of freight. With motor trucks and paved roads, many industries will find it convenient to send

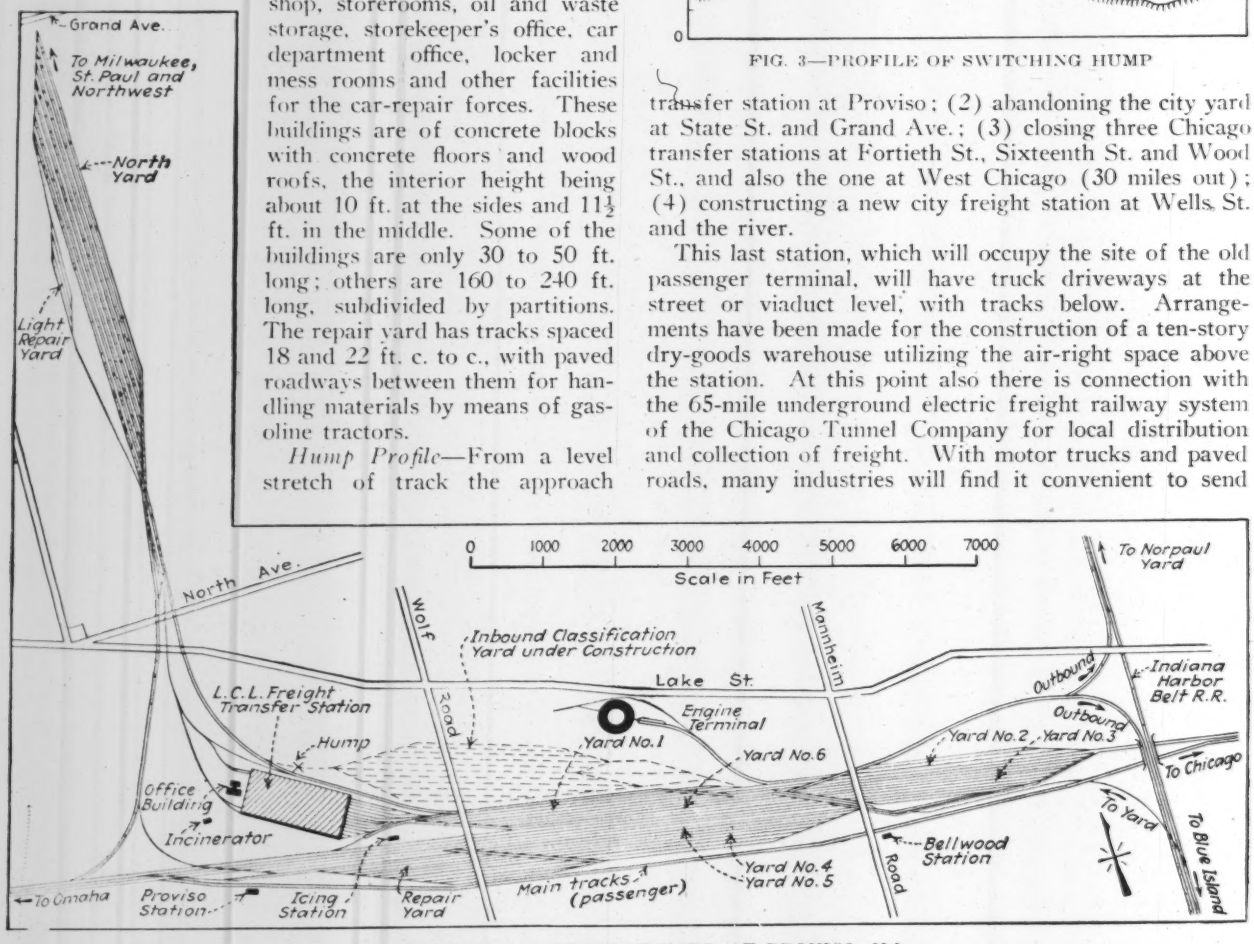


FIG. 2—TERMINAL FREIGHT YARD AT PROVISO, ILL.

Yard No. 1, serving freight transfer station. No. 2, bad-order cars. No. 3, hold and departure yard for north. No. 4, departure yard for west. No. 5, receiving yard for Indiana Harbor Belt R.R. No. 6, departure yard for north.

their shipments direct to the Proviso station, where suitable facilities have been provided.

The report estimated that by the proposed plan there would be an annual saving of 4,600,000 car-miles and 148,300 car-days of local service and about $483,700 in cost of handling freight. It would eliminate much of the delay to both transfer and road trains, the rehandling and reclassifying of cars in various yards and the wasteful transfers between different stations. Shippers would send all l.c.l. shipments to the one Wells St. station, instead of having to send them to different stations for northbound and westbound shipment. The cost was estimated at $3,260,000 for the Proviso transfer station and $2,000,000 for the Wells St. freight station, the latter item being exclusive of the warehouse. The total cost of the entire project was put at about $15,000,000.

All road haul now begins and ends at Proviso. For transfer of inbound through cars to be forwarded, complete trains will be made up here for the respective forwarding roads and taken directly to the yards of these roads over to the Indiana Harbor Belt Railroad. Hitherto these interchange cars have been transferred to a yard of the belt line and there made up into trains for delivery to the several forwarding roads. With many cars, this new method will mean a saving of 24 hours in the transfer movement.

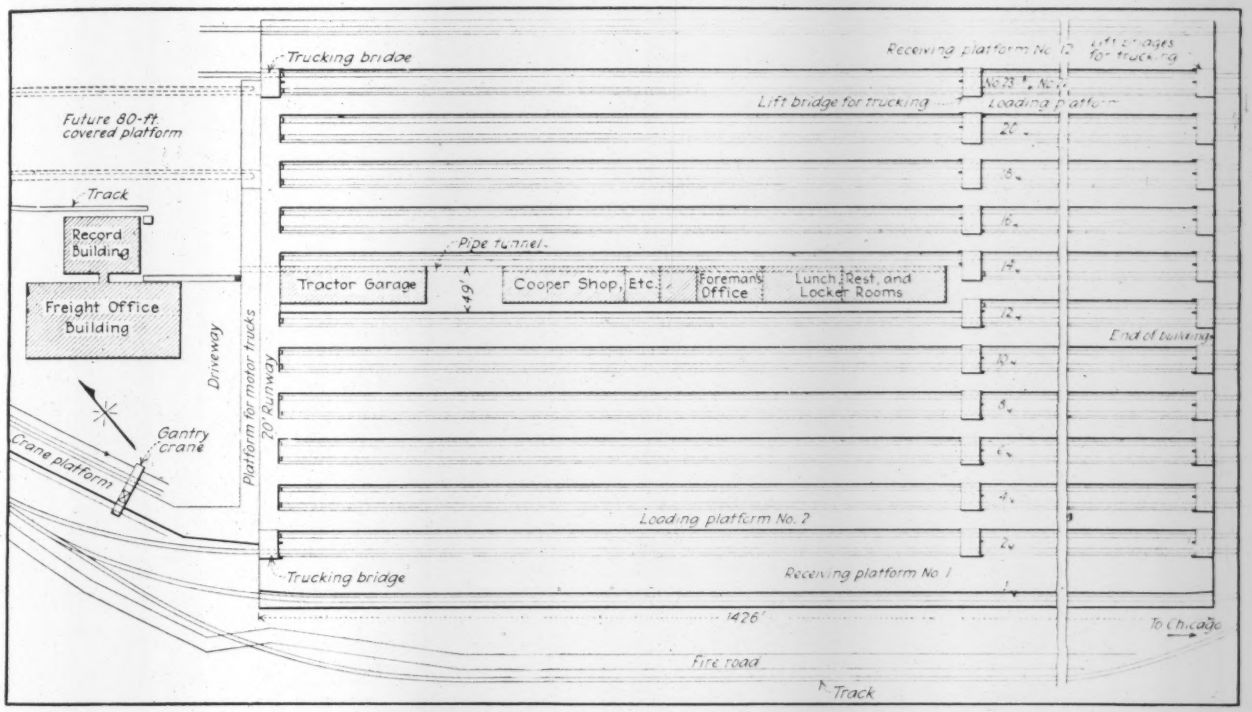


FIG. 4—PLAN OF L.C.L. FREIGHT TRANSFER STATION

Engine Terminal—Engine facilities now provided on the north side of the east yard include a 58-stall roundhouse for road and yard engines, an 80-ft. turntable, open ashpit and timber coaling station with 500-ton storage bin serving two tracks.

L.c.l. Transfer Station—For the transferring of freight there is a one-story structure 1,420x626 ft., housing 24 tracks. Its plan is shown in Fig. 4. Ten platforms 22 ft. wide serve twenty loading tracks having an aggregate capacity of 570 cars. Two receiving platforms 40 ft. wide serve four unloading tracks with capacity for 120 cars each. At each side of the building are two of these unloading tracks, with a platform between them. All the loading tracks are stub tracks with concrete bumping posts. The four unloading tracks extend through the building and are connected at each end with yard tracks.

At this station through freight from lightly loaded inbound cars and outbound freight in cars from the city freight houses are consolidated into full carloads for various destinations on the Chicago & Northwestern Railway. In this way about 690 cars will be released daily as empties, instead of being forwarded with only light loads. Freight from the two unloading platforms is taken to the proper loading platforms by trucks handled in trains by small tractors.

This building is of steel frame construction, as shown in Fig. 5, with rows of columns between the tracks and spaced 20 ft. c. to c. longitudinally. These columns carry riveted bowstring roof trusses, of 68 ft. span for the two outer bays (over the 40-ft. platforms), and 49 ft. for all interior bays. Longitudinal struts of 6x8-in. fir are placed between the heads of the columns, resting on angle brackets. Longitudinal diagonal bracing is introduced in about every eighth panel. In the sides of the building the columns are also connected by a line of longitudinal steel struts. The sides are sheathed with beaded board siding and have no windows. Horizontal diagonal bracing is provided in four transverse bays of the roof.

Creosoted piles of 15- to 20-ft. penetration extend 2 ft. above rail level and support the 16-ft. columns, so that the clear headroom is 18 ft. to the roof trusses. On the top chord of each truss a 2x8-in. plank was bolted before erection. Upon these timbers rest 2x10-in. purlins 20 ft. long, with cross-bridging at the middle of each span. To these purlins is nailed the 1x6-in. plank sheathing, which is covered with a three-ply felt and composition roofing. In the middle of each roof bay and over the platform is a longitudinal skylight 8 ft. wide, of galvan-

ized metal and wire glass, with provision for intercepting water from condensation, so that it will not drip on the platforms or freight. Exhaust ventilators are placed 40 ft. apart along the ridge of each skylight.

All platforms are of timber, on short creosoted piles spaced 8 ft. c. to c. longitudinally and 10 ft. laterally. Caps of 6x14-in. and 8x14-in. fir carry transverse fir joists 4x10-in., spaced 19 in. c. to c. On these is 2-in. hemlock subplanking with a wearing surface of maple $\frac{7}{8}$x2$\frac{1}{2}$ in., laid longitudinally and giving a good surface for trucking. To prevent combustible matter and rubbish from collecting under the platforms, their open sides are covered with wire netting.

Platform Lift Bridges—To facilitate movement of the truck trains and avoid excessive lengths of haul lateral runways connecting the platforms are formed by three sets of vertical lift bridges in the length of the building (see Fig. 4). At the close of the day's work, when the cars are to be removed, the bridges are raised to give a clearance of 16 ft. 8 in. When the cars are set next morning, they are spotted to clear these bridges, which are then lowered level with the platforms.

There are 24 of these bridges, 19 ft. wide and 32 ft. long, each spanning two tracks. Each has a steel frame, with wood deck or floor, working in guides attached to the steel columns at mid-span. At each corner of the frame is a vertical screw within a steel casing set in the ground and protected by a telescopic sleeve when raised. A motor in a pit beneath the bridge is geared to revolving nuts on the screws and is controlled by a push-button device. Limit switches cut off current when the bridge reaches the end of its travel, and the position of each bridge is shown automatically in the general foreman's office by electric lights on an indicator board. The bridge is raised or lowered through its travel of 13 ft. in four minutes. Failure of current or machinery is provided against by a hand hoist and cable attached to the column at each bridge.

Auxiliary Facilities—Service buildings of concrete-block construction on one of the middle platforms of the transfer station provide a garage and repair room for the tractors, storage for car heaters, and lunch, locker and toilet rooms for the employees. These rooms are heated by steam from the heating plant in the office building, the pipes being led through a concrete tunnel 4 ft. wide and 6 ft. high, which contains also the hot and cold water pipes, electric conduits and pneumatic messenger tubes.

For fire protection of the transfer station there is an open reservoir of 1 m.g. capacity serving a duplicate set of fire pumps of 1,000 g.p.m. operated by 100-hp. motors with automatic control. Along each platform are seven 3-in. hydrants with hose and nozzle attached, reached through trap doors which are plainly marked. Constant pressure is maintained in the line, and if this is reduced by opening a hydrant valve, the motors and pumps are put in operation automatically to restore and hold the normal pressure. For drinking water service, there is a deep-well pump supplying a 30,000-gal. tank on a 75-ft. steel tower, and serving both taps and bubbling fountains.

A concrete driveway leading from Lake St. to the transverse platform across the west end of the building

TABLE II—PROVISO TERMINAL YARDS; C. & N. W. RY.

	Tracks	Cars Per Track	Total Cars
A. North Yard			
For Galena Division:			
Receiving yard	15	100	1,560
Departure yard	15	100	1,500
For Wisconsin Division:			
Receiving yard	15	100	1,500
Departure yard	15	100	1,500
Light repair yard	16	...	355
Reclassification yard	10	...	170
Outbound classification	52	32 to 72	2,830
Total	138	....	9,355
B. East Yard			
I.H.B.R.R. receiving yard	15	98 to 114	1,650
I.H.B.R.R. departure yard	15	96	1,440
City receiving yard	15	100	1,500
City departure yard	14	93 to 96	1,325
Storage yard A	16	56 to 70	910
Storage yard B	14	40 to 93	1,230
Storage yard C	15	54 to 88	890
Storage yard D	15	11 to 60	560
Storage yard E	15	60 to 90	1,320
Hold yard	15	....	300
Light repair yard	17	....	237
Inbound class. yard	52	42 to 75	3,100
Total	218	....	14,462
Grand total	356	....	23,817

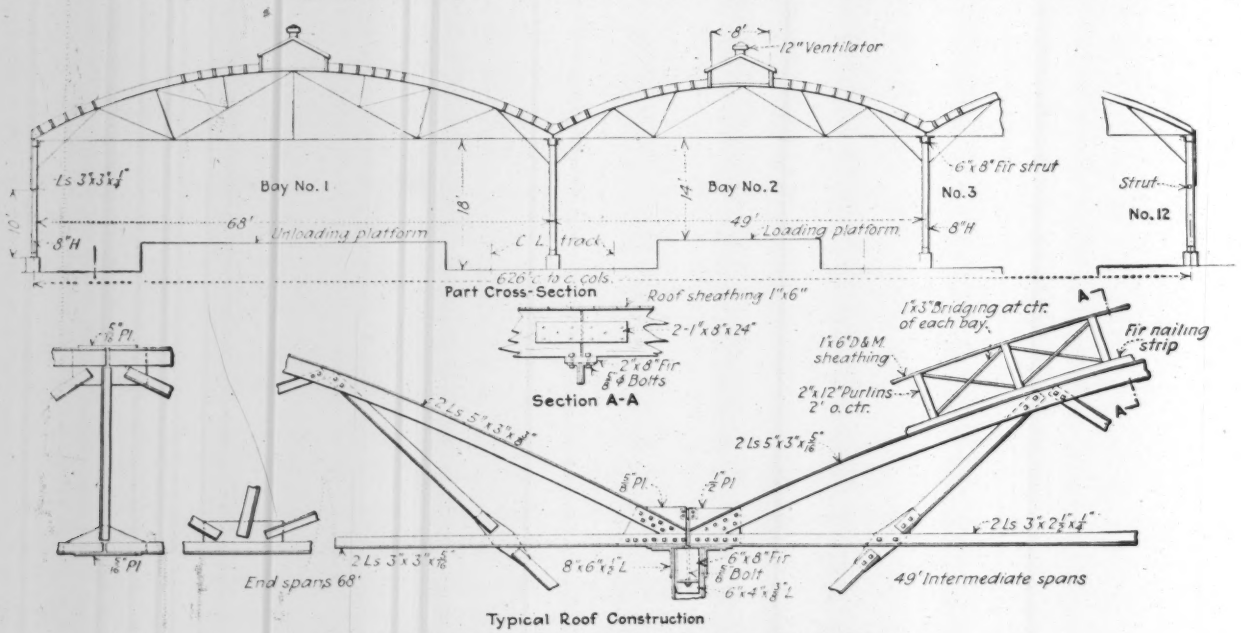


FIG. 5—STRUCTURAL FEATURES OF TRANSFER STATION

provides for motor trucks delivering outbound freight directly at the Proviso station. Near this end of the building also is a 10-ton gantry crane spanning an outside track and platform and used for handling bulky or heavy freight. An incinerator at a little distance from the transfer station provides for the disposal of dry rubbish such as packing material and broken crates. A septic tank takes care of the sewage.

Office Buildings—All freight records are now handled at Proviso instead of at the city offices. For this purpose two reinforced-concrete two-story buildings have been erected. (See Figs. 2 and 4.) Their red brick curtain walls are backed with hollow tile and the concrete floors rest on 9-in. pressed steel joists. The record building is 80x60 ft., with floor panels 15x16 ft., and is equipped with steel shelves for filing. In the basement are the heating plant, pneumatic tube machinery and telephone equipment room. The office building, 80x160 ft., has a cafeteria, as there are about 600 employees and the building is in the open country, far from any restaurant facilities. Two separate pneumatic-tube systems extend from the office building to carry waybills; one leads to the foreman's office in the transfer station and the other to the foremen's offices at the north yard (1 mile) and east yard (1½ miles).

Final Layout—In the final layout as planned, shown in Fig. 6, all road freight trains will enter and leave the north yard, which will then comprise the several separate yards listed in Table II. The east yard, also listed in the table, will then serve entirely for the city transfer, local and interchange service. With this arrangement all inbound cars from road trains in the north yard will be passed over the present hump into the inbound classification yard, to be arranged for transfer to the city freight houses or to industries, or for interchange for other roads. In the same way all city and interchange cars received in the east yard will be passed westward over a hump to the outbound classification yard, to be arranged for outbound road trains to various points.

Adjacent to the inbound classification yard will be the icing station. The engine terminal will have two roundhouses of 58 stalls each, with water service, coaling station, ashpits and other facilities in duplicate, and with parking tracks for twenty engines outside each roundhouse. The total cost of this complete freight terminal when completed will be about $16,000,000.

Engineers and Contractors—Following the general scheme of the railway committee's report of 1924, the details of planning and construction have been carried out under the direction of W. J. Towne, chief engineer, Chicago & Northwestern Railway, with George A. Saint as assistant engineer in direct charge of the work. The transfer station was built by the Peppard & Burrill Company, Minneapolis, Minn., and the office building by the Ellington Miller Company, Chicago. Part of the grading was done by John Marsch, Inc., Chicago, and C. G. Blythe & Sons, Tama, Iowa; but the filling of the site and all track work have been done by railway forces.

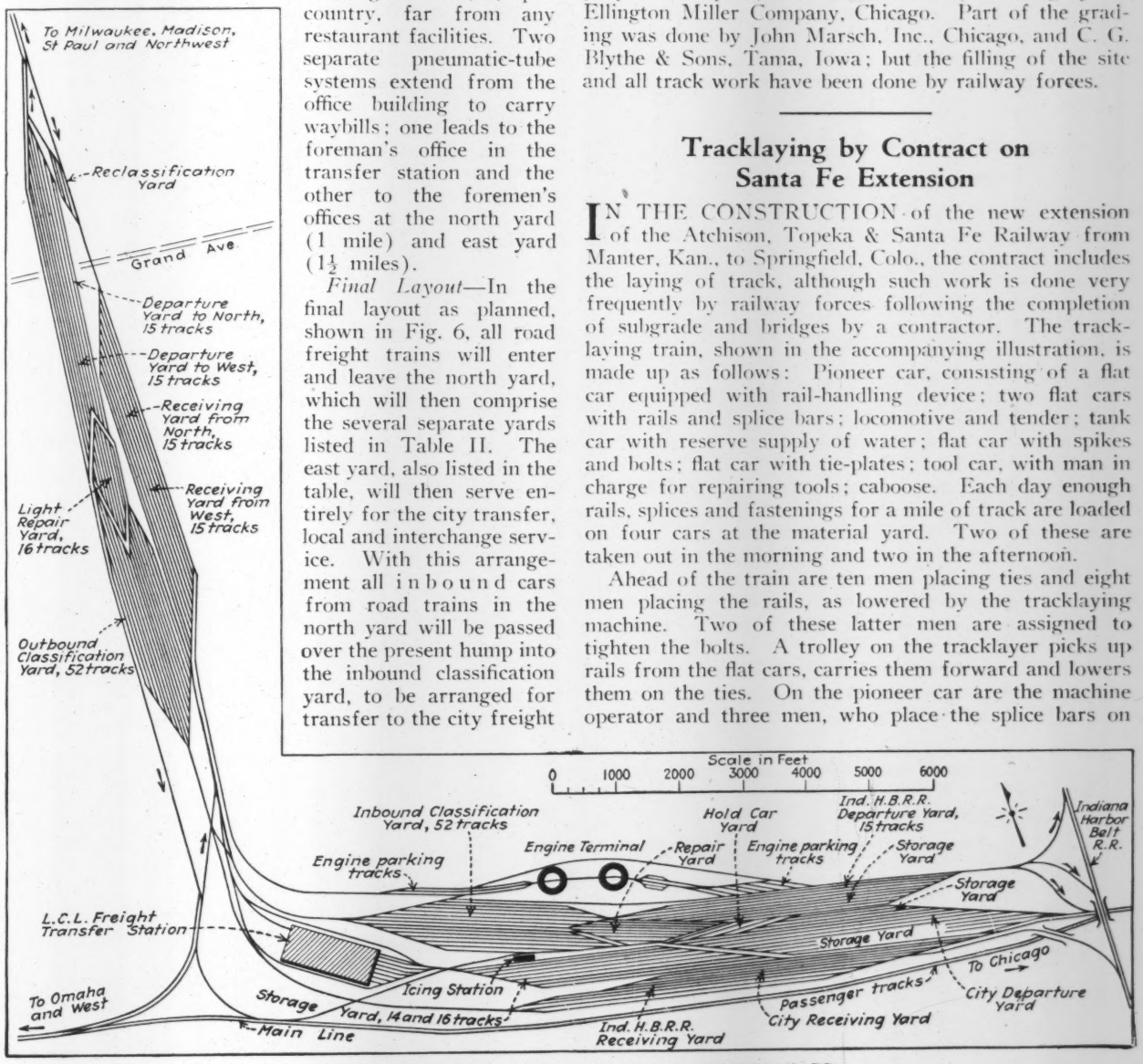


FIG. 6—FUTURE COMPLETE PLAN OF PROVISO YARD

Tracklaying by Contract on Santa Fe Extension

IN THE CONSTRUCTION of the new extension of the Atchison, Topeka & Santa Fe Railway from Manter, Kan., to Springfield, Colo., the contract includes the laying of track, although such work is done very frequently by railway forces following the completion of subgrade and bridges by a contractor. The tracklaying train, shown in the accompanying illustration, is made up as follows: Pioneer car, consisting of a flat car equipped with rail-handling device; two flat cars with rails and splice bars; locomotive and tender; tank car with reserve supply of water; flat car with spikes and bolts; flat car with tie-plates; tool car, with man in charge for repairing tools; caboose. Each day enough rails, splices and fastenings for a mile of track are loaded on four cars at the material yard. Two of these are taken out in the morning and two in the afternoon.

Ahead of the train are ten men placing ties and eight men placing the rails, as lowered by the tracklaying machine. Two of these latter men are assigned to tighten the bolts. A trolley on the tracklayer picks up rails from the flat cars, carries them forward and lowers them on the ties. On the pioneer car are the machine operator and three men, who place the splice bars on

the rails as they are brought forward. Two men on the rail car attach the tongs of the trolley hoist to a pair of rails. On the other cars two men unload spikes and bolts and two unload the tie-plates. These plates as distributed are placed on the ends of the ties, being put under the rails by the back gang.

Three or four cars of ties are attached to the train when it leaves camp, but these are cut off near the end of track. The ties are then unloaded by four men, paid by piecework. They are hauled ahead by trucks and distributed about ½ mile in advance of the steel or rail train. The force for this work consists of eight men loading the trucks and eight men driving them. Unloading the trucks is done by two men of the tie gang ahead of the tracklaying train. The track is full tied in front of the train, but has only two bolts in each joint, while the rails are held by bridle rods instead of spikes, all spiking being done behind the train.

A back gang of about 61 men completes the track work: four men put the remaining two bolts in each joint, six space the ties, four put the tie-plates under the rails, 26 spikers with thirteen nippers follow (seven sets of spikers on the line rail and six on the other rail), and eight men tighten the bolts. At intervals these eight bolt men and the last two sets of spikers (six men) are taken to line the track.

All this work is in charge of six foremen: (1) with men on train and laying rails; (2) with tie-spacing gang behind train, and men distributing spikes and tie-plates; (3) with four leading sets of spikers; (4) with second four sets of spikers; (5) with remainder of spikers, and in charge also of rear men on bolts and of the lining of completed track; (6) with tie gang unloading and distributing ties.

The rails are of 90-lb. section, mainly in 33-ft. lengths, but about 10 per cent are 39 ft. long. Progress has averaged a mile a day when conditions are good and there are no engine troubles. Surfacing is done about 2 to 10 miles behind the tracklaying, the material being loaded with an elevating grader and hauled in ballast cars.

A curious structure involved in the work was a temporary bridge built with high cribs composed of track ties as shown in the illustration. In advancing the tracklaying across dry streams it has been found more satisfactory to crib the openings than to use a ground piledriver ahead of the track. The cribs can be put in at little expense by the tracklaying crew, so that the train can pass and continue its work without being held while a pile trestle is put in. This plan keeps the tracklaying organization intact and prevents laying off the men. A railway track piledriver follows to put in the permanent trestle, and when this is completed the cribbing is removed by a locomotive crane.

The Cook-O'Brien Company, Kansas City, Mo., has the general contract for building this extension complete, including tracklaying and surfacing. The work is under the general direction of G. W. Harris, acting chief engineer of the Atchison, Topeka & Santa Fe Railway System.

Plate-Girder Railway Bridge Built by Welding

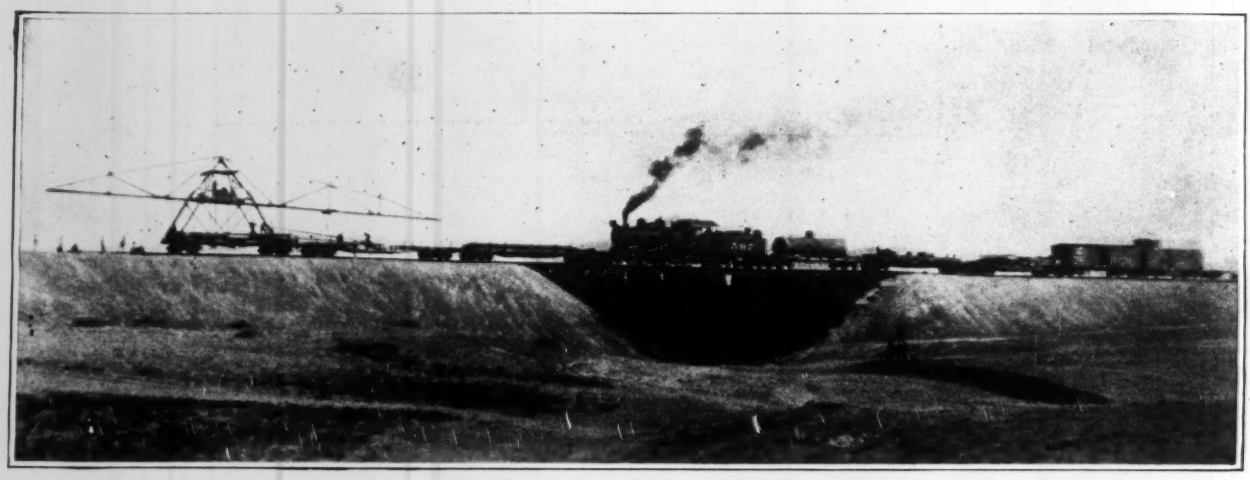
Structure of 53-Ft. Span Uses Girders Built Up From Flat Plates—Design Utilizes Continuous Stringers

By A. G. Bissell
Arc-Welding Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

A STEEL plate-girder railorad bridge of 53-ft. span has recently been fabricated and erected by arc welding by the Westinghouse Electric & Manufacturing Company to carry rail traffic between the company's Linhart works and East Pittsburgh works. It is designed to carry a 185,000-lb. locomotive on three sets of drivers. The bridge consists of two 60-in. girders 52 ft. 5 in. and 53 ft. 9 in. long respectively, each weighing about 11,600 lb. It crosses a small stream at an angle of about 60 deg.

An important feature of the design is a detail providing continuous stringers. The floorbeams are 24-in. I's framing into the girders at right angles, and the stringers, which frame between the floorbeams, are 18-in. I's. To make these stringers continuous a slot was cut in the webs of the floorbeams and a 5x⅜x24-in. splice plate was passed through and welded to the top flanges of the stringers.

Girder Fabrication—The girders are built up entirely of flat plates. For flanges three plates are used. The inner one is a 14½x⅝-in. plate, to which the 54x⅜-in. web is attached by two ⅜-in. fillet welds extending the length of the web. The two other cover plates are



TRACKLAYING TRAIN CROSSING CRIBBED BRIDGE

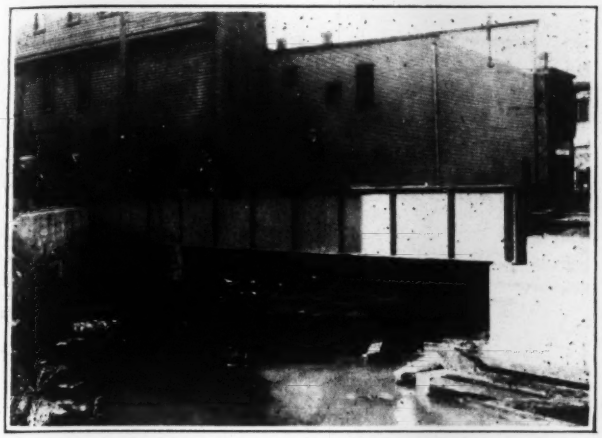


FIG. 1—ARC-WELDED PLATE GIRDER RAILWAY BRIDGE WITH 53-FT. SPAN

respectively $15\frac{1}{4}$x$\frac{1}{2}$ in. x 38 ft. long and 16x$\frac{1}{2}$ in. x 22 ft. long.

While attaching the web plates to the flanges, two 6x6x$\frac{1}{2}$-in. angles were temporarily bolted to the web plate, as shown in Fig. 2, to give the web rigidity in handling. The small angles shown in this illustration tacked along the center line of the flange plates were used to center the web prior to tack welding, after which they were removed. With the web secured to the first flange plate, the web stiffeners, plates 4x$\frac{3}{8}$ in. x 4 ft. 6 in., were located and welded. This permitted the welding between the end of the stiffener and the flange to be done in the downward position. By making the outside cover plate the widest and the others successively narrower, the fillet

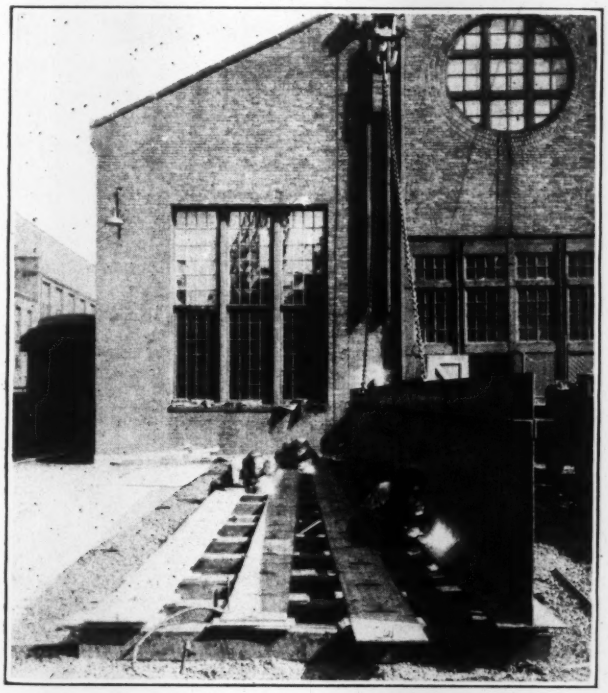


FIG. 2—FABRICATING STEEL GIRDERS FROM FLAT PLATES

Temporary clip angles on cover plates used to locate web until tack welding is complete. Stiffener angles near top of web are bolted temporarily to the web to assist in handling. Arrangement of work planned for downward welding.

welds connecting these plates could also be made in the downward position.

Following the welding of the first flange plate and the web stiffeners, the assembly was turned over and the web edge located between the small angles on the second flange preparatory to welding. Between the flange and web $\frac{3}{8}$-in. fillet welds were used, whereas between the web stiffeners and the flange and web plates only 5/16-in. fillet welds were necessary. The 4x$\frac{3}{8}$-in. stiffeners were omitted where the floorbeams were attached to the girder web, and in their places $\frac{3}{8}$-in. plates 14 in. wide at the end joining the floorbeam and tapering to 4 in. at the top, as shown in Fig. 3, were used. To these combination stiffeners and braces were welded 6x$\frac{3}{8}$-in. plates as flanges. In order to give a finished appearance to the completed girders, $14\frac{1}{2}$x$\frac{3}{8}$-in. plates were welded to the ends of each, as may be seen in Fig. 1.

When the girders were completed, the entire bridge was assembled without welding in order to check the fit

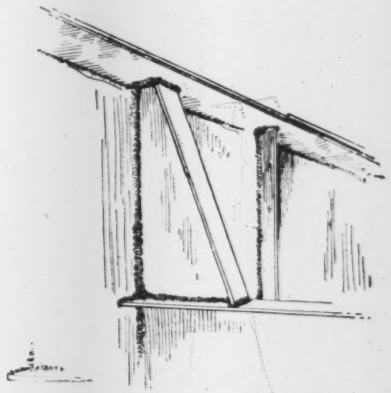


FIG. 3—COMBINATION STIFFENER AND KNEEBRACE AT FLOOR-BEAM CONNECTION TO GIRDER

of the members. The parts were then loaded on flat cars and taken to the site, the old bridge was torn out, the new bridge girders were erected and the floor beams and stringers were welded in place. About three days were required before the tracks were replaced and traffic resumed.

In the construction of the girders three welders were employed; in the assembly at the site six welders were necessary. The welding current was supplied by Westinghouse single-operator motor-generator sets. A total of 1,057 lin.ft. of $\frac{3}{8}$-in. fillet welds and 501 lin.ft. of 5/16-in. fillet welds was placed on this job, requiring about 500 lb. of electrode material and 320 man-hours of welder time. Altogether 39,300 lb. of steel was used in the structure.

South Africa Purchases Steel Railroad Ties From Germany

An order for steel railroad ties, amounting to approximately 10,000,000 marks (about $2,500,000) has been obtained by German firms from the government of the Union of South Africa. In view of the continuously decreasing supply of timber in South Africa, the railways will equip all their lines with steel ties. The total orders received by German firms during 1927 amounted to more than $5,000,000.

Improved Methods Used in Surveys for Extending Piedmont & Northern Railway

Plane-Table Used to Advantage in Taking Topography and in Other Field Work—Very Complete Plans and Profiles Made—Standard Tables Prepared for Taking Off Estimates of Quantities

CONSTRUCTION of the present Piedmont & Northern Railway was begun by the late J. B. Duke in 1911 to aid the industrial development of the Piedmont section of the Carolinas. By the end of 1912 two portions of the line had been completed, one in South Carolina from Greenwood, through Greenville to Spartanburg, with a branch to Anderson, a total of 101 miles, and a shorter line in North Carolina from Gastonia to Charlotte, a distance of 23 miles. Ultimately it was proposed to extend the line through Salisbury to Winston-Salem and eventually to Durham, N. C. Reconnaissance surveys for part of this project were made previously to 1917 and rights-of-way at strategic points were purchased, to enable getting through some of the cities and to connect with local traction lines. The war put a stop to the work and, except for the functioning of one locating party in 1925 and 1926, nothing more was done until February, 1927, when three locating parties were put in the field, one on a 52-mile connecting link from Spartanburg to Gastonia, and two on a 73-mile extension from Charlotte to Winston-Salem. In these days of limited railroad construction such extensive surveys are uncommon. The work done on the Piedmont & Northern surveys, moreover, is of special interest because some of the methods used differ from those used in such surveys in the past.

The region served by the Piedmont & Northern Railway is well suited for industrial development; plenty of cheap power is available and labor is plentiful. Although two of the major railway lines of the Southeast run through the territory, the Southern Railway and the Seaboard Air Line, the late J. B. Duke believed that there was need for an additional railway the primary purpose of which would be to render local rather than through service. By using electric traction such a line would give a switching service beyond the limits possible with steam locomotives in the hilly country characteristic of the region.

The portions of the railway built in 1911 and 1912 were constructed along these lines. Normal grades and curvatures were used between the towns, but on spurs into mills and around industrial sites curves up to 30 deg. and grades up to 7 per cent were employed.

Characteristics of the New Line—The same general arrangement was adopted for the projected extensions which were located in 1927. On the main line, which is single-track, grades have been kept down to 1 per cent compensated for curvature, and curves are all 4 deg. or under.

As shown in Fig. 1, the new line runs about at right angles to the major stream valleys and as a consequence the profile is irregular, being made up of many short stretches in which the maximum grade is used in getting over minor summits. The country is rolling, with no pronounced characteristics, a difficult region in which to locate a railroad with any assurance that the most economical line will be found. The soil is clay, through which the streams have cut deep gullies. It is not rich agriculturally and much of it has never been cleared. Despite these adverse conditions, the line as located between Spartanburg and Gastonia, a distance of 52 miles, loses only an average of 130 ft. per mile over a straight line and gains 4 miles over the Southern Railway, which was the first line to be located through the region. In the process of making such a comparatively straight location the line has been run into heavy grading, as shown in the typical section of profile in Fig. 3.

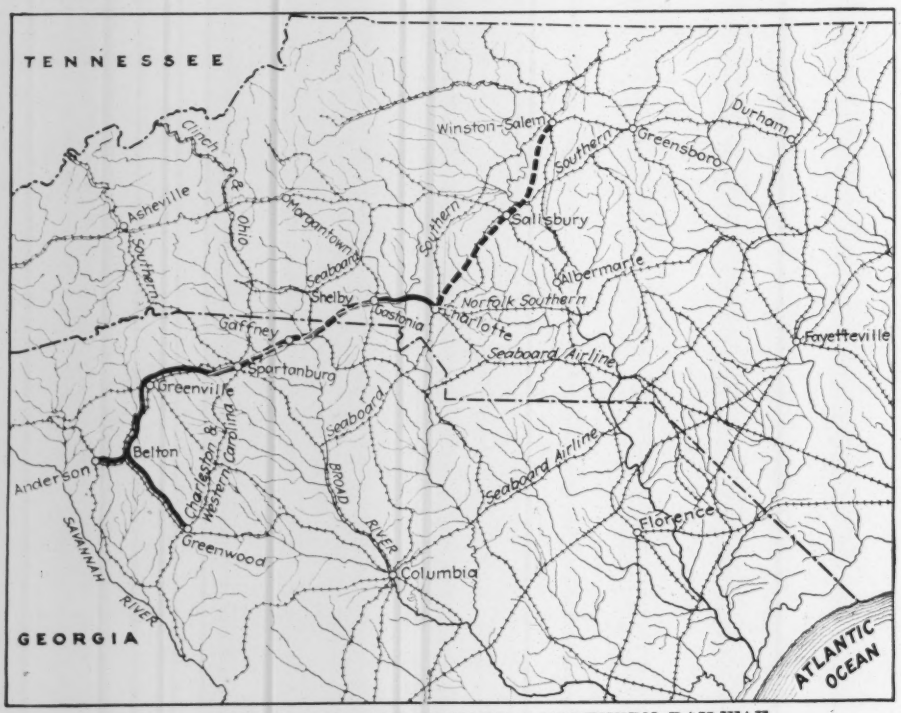


FIG. 1—GENERAL MAP OF PIEDMONT & NORTHERN RAILWAY

Surveys—Preliminary surveys were begun in 1927 with three parties in the field, the parties generally being made up of a chief, with transit, level and plane-table parties under him, usually fifteen to twenty men in all. The parties lived in tents close to the work, rather than in the towns. For the greater part of their length, the two lines

are not far from country roads, making it possible to get to them conveniently with motor cars. This fact cut down much of the time frequently lost on such surveys going to and from work.

Use of Plane-Tables—A radical departure from methods used in railroad surveys in the past was made in the use of plane-tables for taking topography. For this operation the preliminary line was plotted on plane-table sheets to a scale of 1 in. = 200 ft., plotting by the use of co-ordinates in order to insure accuracy. This plotting was done in ink, so that the line would not be erased by hard usage in the field. On these sheets 5-ft. contours were plotted directly in the field as the work progressed. Ability to plot contours on the base map in the field was found to be one of the chief advantages of the use of a plane-table. It not only eliminated the errors that creep in through the misinterpretation of notes in the office, but it also resulted in more accurate work, as the instrumentman with the ground before him was able to sketch in the contours much more accurately than he could have done in the office.

Where there was not too much underbrush, a plane-table party was able to cover about 2 miles a day. Hand-level parties could cover only half a mile a day in similar country. However, it was found that where the country was rough and very much overgrown or dropped away from the line sharply, hand-level work was quicker. A source of error that was eliminated by the use of plane-tables is that which results from failure to keep hand-level lines perpendicular to the center line where they are run out to a considerable distance.

Line Location—As the plane-table sheets were completed they were matched up on long tables in the field office for the purpose of making the first paper locations. When the line had been determined upon, the tangents were produced to intersection, their bearings calculated, and the central angles and tangent distances of all curves computed and tabulated for field work in running the lines. The accuracy of the field work of the preliminary survey was such that very few changes were necessary in fitting the line to the ground.

Plane-tables also were used in making "situation maps" at bridge sites and for mapping the drainage areas of small streams for which there were no stream-flow records. At each major stream crossing, railway and highway crossing, situation maps were prepared to a scale of 20 ft. to the inch and with 2-ft. contours. These maps were used to work out the most economical type of structure for each location. Drainage areas of small streams were surveyed to determine the size of culvert required. Talbot's formula was used to estimate the runoff.

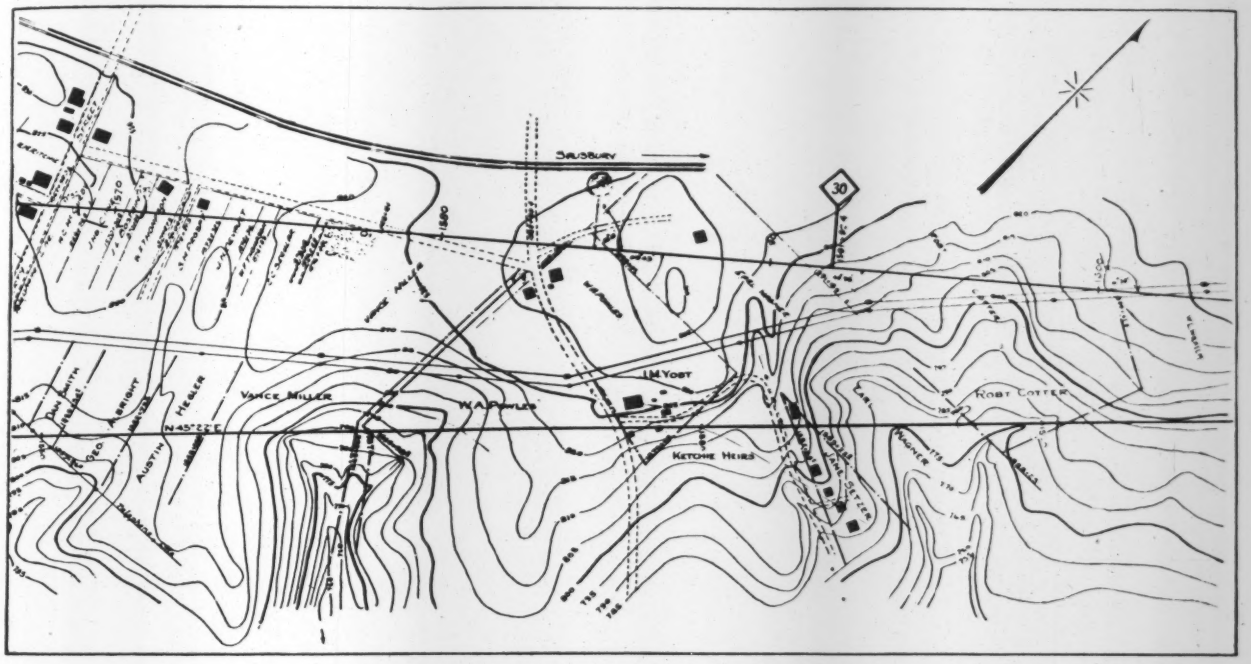


FIG. 2—PART OF A SHEET OF THE BASE MAP

Ordinary drawing paper was used for the plane-table sheets, but they became so torn at the edges before the work was completed that it was evident that mounted sheets would be more satisfactory.

All property lines and land lines were put on the base map sheets. When they were sent in to the main office they were matched up in groups to give 2 miles of track to a group and then were traced. These sheets to a scale of 200 ft. to an inch and having 2 miles of track to a sheet conform to the Interstate Commerce Commission standard.

From the base maps, right-of-way maps to a scale of 100 ft. to the inch were prepared. This larger scale was found to be more suitable for the purpose and the use of separate maps avoided complicating the information put on the base maps.

Profiles were prepared along conventional lines, 400 ft. to the inch horizontal and 20 ft. to the inch vertical. Subsequently, data as to quantities of cut and fill, character of culverts and material required, highwater marks at bridges, road crossings and major land lines were added.

Estimates of Quantities—Special care was taken in the preparation of estimates of the quantities of material

involved in the proposed construction, in an effort to eliminate the personal factor as far as possible. Before estimating was begun, tables of cut and fill for various widths of roadway were prepared, both for uniform cross-sections and for a variety of irregular sections. Standard designs for culverts were made and quantities of excavation and material for various heights of fill over the culverts were prepared and reduced to tabular form for field use. With these tables, uniformity of estimates was reasonably assured and comparative estimates of alternate locations could be made by different men with confidence that they were on a comparable basis.

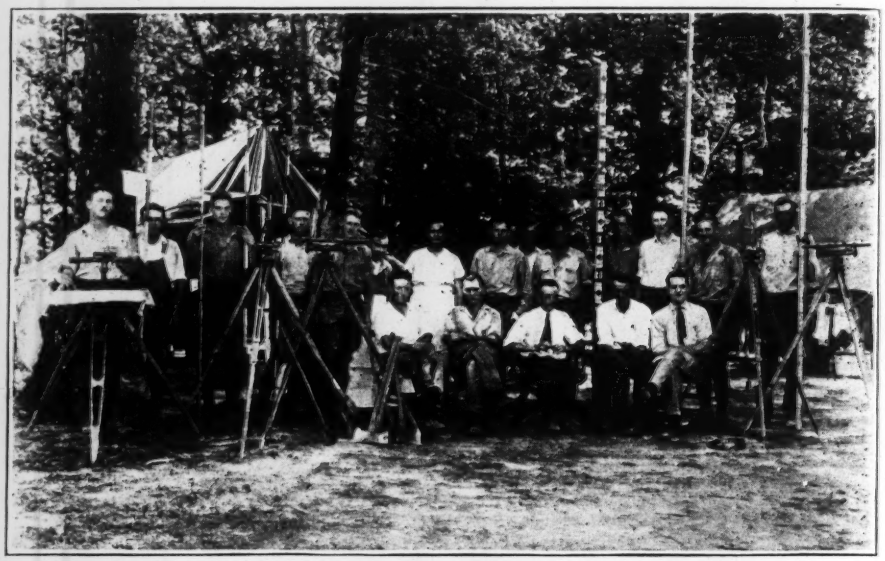


FIG. 4—TYPICAL FIELD PARTY ON THE LOCATION SURVEY

In preparing the bridge and culvert designs, reinforced concrete was specified in most cases, even in heavy foundation work. This was done because stone and sand for concrete are not available along the line but will have to be imported when construction is undertaken. Consequently, the added cost of reinforcing steel and the more complicated formwork was found to be more than offset by the saving in concrete. Also, it was found that it will be cheaper to build small reinforced-concrete box culverts than to haul concrete pipe to many of the less accessible sites. However, as concrete pipe can be put in much more quickly than a box culvert, it will be used wherever the construction of a box culvert would hold up grading work.

Standard designs for small bridges are included in the estimating tables, but in the case of larger bridges and other structures, such as highway overcrossings, detailed maps of the site were made as noted previously and comparative designs were prepared. A construction program has been worked out for each of these larger structures and the necessary temporary structures designed in order that construction work will not be held up while such details are worked out.

Construction Held Up—Actual construction of the line has not been undertaken pending a decision on the part of the Interstate Commerce Commission as to whether construction is to be authorized or not. When the first portions of the Piedmont & Northern Railway were built, previously to the war, certificates of convenience and necessity from the Interstate Commerce Commission were not required, but as such certificates are now required and as the construction of these connecting links of the Piedmont & Northern has been actively opposed by other railroads serving the same territory, the company has made formal application for such a certificate. Up to the present time the commission has not rendered a decision. Comment upon the peculiar circumstances surrounding this case was made in *Engineering News-Record* of Oct. 27, 1927, p: 658.

Engineering Staff—The engineering work was carried on under the supervision of F. H. Cothran, chief engineer; P. W. Early, C. K. Conard, T. C. Marshall and O. B. Bestor as division engineers, A. J. Pearcy and P. H. Morgan as chiefs of party and C. E. Drummond, Jr., as office engineer.

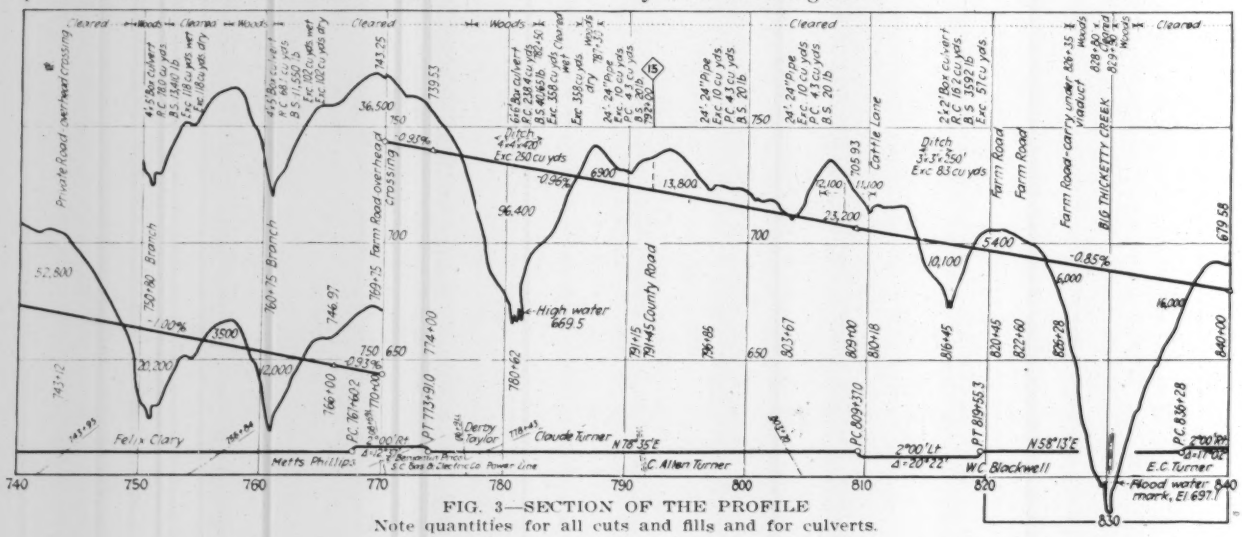


FIG. 3—SECTION OF THE PROFILE
Note quantities for all cuts and fills and for culverts.

Economy in Framing Timber and Ties Before Treatment

STOCKING, framing and treating railway timber at a central plant results in better work, less waste and lower cost as compared with framing done in the field and stocks carried at several points along the line. This statement summarizes in brief a paper read at the annual meeting of the American Wood Preservers Association by Earl Stimson, chief engineer of maintenance of the Baltimore & Ohio Railroad, who was able to speak from direct experience. Following is an abstract of the main parts of this paper. —EDITOR.

IN THE consideration of this subject, two phases present themselves: (1) The economies derived from the longer service life of timbers framed before treatment, and (2) the possible economies in labor due to framing the timbers by machinery before treatment at the treating plant. The first may be considered indirect or ultimate economies, whereas the second are direct and immediate. These last are of most interest to the maintenance engineer, as he is called upon to effect economies that will reduce expenses now, not twenty years hence.

Adequate treatment means considerable cost. To realize the maximum returns, great care must be used in protecting the timber before and after treatment. Nothing should be done to penetrate the heavily treated outer zone and expose the lighter treated interior. To prevent this it has become well-established practice to adze and bore ties before treatment. With better reason, all bridge ties and timbers should be framed, sized or cut to length before treatment. Framing and cutting them in the field is an awkward and expensive operation, done generally by the crudest methods of handling and with hand tools, giving considerable waste in cutting. Much of the work is done in unfavorable weather, which further increases its cost. The use of machinery generally leads to a centralization of effort and mass production, which are the fundamentals of economy.

Wood-Working Mill—The treating of timber requires that a large stock be concentrated at the treating plant for seasoning, which gives the opportunity to centralize the framing work and justifies the building of a mill equipped to cut and gain bridge ties and guard rails; cut posts, caps and sills to length; plane to thickness caps, stringers and trestle ties, and cut bevel ties from blanks. This will require a 40-in. cutoff saw, 36-in. table ripping saw, 8-in. gainer, adjustable swing parallel saw with dado head for rivet grooving, planer with four heads to take timbers up to 14x20 in., swing-arm boring machine, carriage sawmill, portable electrical boring machines, and a pneumatic shaving and sawdust collection system. Such a mill, with a light steel building, will cost about $40,000.

In such a mill built by the writer at the treating plant of the Baltimore & Ohio Railroad, all machines are motor driven, with current furnished from the treating plant. As several of the machines were taken over at a depreciated value from the motive power department, the actual cost of the mill was $32,290. This mill was started in January, 1925. Its output of 58,924 pieces, or 5,138,295 ft. b.m., for 1927 includes bridge ties, trestle ties, guard rail timbers, caps, stringers and miscellaneous work. The cost of framing the bridge ties and guard rails, including both operating and fixed charges, was $5.74 per 1,000 ft. b.m., as compared with $16 when done by hand. Sizing trestle ties and timbers—that is, cutting to length and planing to thickness—cost $3.42 per 1,000 ft. b.m., as compared with the $7 additional cost if bought sized to thickness. The miscellaneous items cost $6.03 per thousand, with a saving of about 50 per cent. On this basis the total savings for 1927, effected by handling the timbers through the mill as compared with hand work along the railroad, amount to $31,000, or nearly a 100 per cent return on the investment.

Economic Aspects—Each year the output has increased, the scope of the work extended and the unit costs decreased. The value of the increased life of the treated timber that accrues from preframing can only be estimated, but the savings made by the machine method of framing are subject to exact determination. It may be assumed that well-treated preframed timber has a service life of 25 years; also that on account of framing and boring after treatment, decay attacks the exposed untreated interior and reduces this life to eighteen years. There is, then, a loss of seven years' service. With the cost of timber in the structure taken at $105 per 1,000 ft. b.m., the annual cost for eighteen years' life is $9.70 and for 25 years' life it is $8.21. Preframing thus saves $1.49 in annual costs, or $37.25 during the 25-year service life of the timber. The average is probably much less, as much of the timber is so thoroughly treated that framing after treatment has no serious effect.

When it was first proposed to frame all bridge ties and timbers at a central plant, disastrous results were prophesied, but the prophecies have not come true. Much of the framing is of timbers of standard dimensions and requires no special information or plan. This includes trestle ties, which are cut to standard length and sized to uniform thickness and not dapped, the sizing of stringers and caps and the framing of guard rails and standard bridge ties with daps of uniform width and depth. For other than standard dimensions, it is necessary to furnish the mill with framing plans giving in detail the dimensions. This becomes somewhat complicated on long deck girder spans with varying number of cover plates. When on a curve, it becomes still more interesting. The framing plans for renewing existing decks are made up on the divisions from measurements taken in the field. For new bridges and the more complicated renewals, special framing plans are made up by the bridge engineer. When there are ties of several framings on a bridge, they are numbered on the plan, and these numbers are stamped on the ends of the ties for identification in placing on the bridge. It is remarkable how few misfits are found and these are most often the result of mistakes in the framing plans.

Recently a complete bill of framed and treated timbers, amounting to 220,000 ft. b.m., was sent out for a trestle 936 ft. long. Field framing was eliminated entirely. We are about to frame and treat the timbers for a 103-ft., double-track, three-truss float bridge of the Howe truss type. Doing this work at a well-equipped mill saves in labor costs, does a better job, saves waste in cutting and reduces the weight and bulk to a minimum, which effects a saving in cost of handling and freight. There is also a considerable indirect saving through the more effective control of the timber stock by having it concentrated at the treating plant, where it can be properly cared for. This makes possible the carrying of a smaller timber stock and a large reduction of waste, as compared with a system under which the stock is scattered along the railroad.

Motor Truck and Light Cars Used to Dismantle 165-Mile Railway

Condition of Track and Bridges Made Use of Locomotives Impracticable—Rail and Fastenings Loaded on Light Industrial Cars, Which Could Be Set Off the Track by Hand

By T. E. Rust
Chief Engineer, Waterloo, Cedar Falls & Northern Railway, Waterloo, Iowa

NOT a great deal appears to have been published on the subject of salvaging the metal parts of an abandoned railway and as, unfortunately, it seems probable that much of this sort of work will be done in the next few years, a description of the methods used in the recent wrecking of a short railroad in Kansas and Nebraska may be of interest. This line, known as the Kansas City Northwestern Railway, was about 165 miles long and extended from Kansas City, Kan., to Leavenworth, Kan., and Virginia, Neb. It was built about 40 years ago and for a long time was a prosperous road serving a good territory, for which it was the short route to the Kansas City grain and livestock markets. De-

TRAIN READY TO DETOUR OVER FOREIGN LINE TO NEXT SET-UP
Derrick, hoist and tools are loaded on the small cars.

clining business, no doubt mostly due to automobile and motor truck competition, finally caused it to suspend operation in 1919, although hope for its resurrection was not abandoned until late in 1925. When dismantling was finally begun in May, 1926, the ties and wooden bridges, of which latter there were 234, were in such condition that the usual methods of wrecking were out of the question.

The cost of putting the track in shape to handle a light locomotive or even a standard flat car would have been prohibitive; therefore it was necessary to devise something different. The methods thus forced upon those charged with the work of dismantling the line might be advantageously used in wrecking roads not so completely deteriorated. At any rate it may be worth while to describe the operations, if only with the hope that the example may inspire someone with a better plan to make it public.

General Plan—The method of dismantling the railway was, briefly, as follows: The rail and other metal parts were loaded upon industrial cars holding about 6 tons each and were hauled by motor truck to the nearest railroad junction, where they were reloaded in standard gondolas or on flats by means of a gasoline hoist and stiff-leg derrick. There is nothing particularly novel about this method. Motor trucks with flanged wheels are run over the rails in many places and for various purposes. The only features of interest in this work were the design of the equipment and the methods used to make the operation of tearing up and loading rail as nearly continuous as possible. The accompanying operation diagram gives a good idea of the general scheme, and a discussion of the merits of this method of wrecking will therefore be postponed until the equipment used has been described in some detail.

Type of Motor Truck Used

The truck used in this work had a nominal capacity of 2½ tons, this being about as heavy a truck as it was thought practicable to use over such track and bridges. In other circumstances a heavier truck might be better. The motor was oversize in order to give plenty of power, and the rear end was loaded to capacity to get as much tractive effort as possible. This truck proved to be rugged and generally satisfactory. Such faults as developed in service were due to our own inexperience, resulting in a failure to specify details to fit the unusually severe conditions. These faults were: (1) Insufficient tractive effort and braking power on slippery rail, which could have been almost entirely overcome by properly designed sanders. (2) Slipping of the steel rim on the wood wheels, a fault that did not develop until after about eight months of service. (3) Inadequate provision for cooling the water while running backward. (4) Too short a platform back of the cab. (5) Failure to provide properly designed ballast. The truck had plenty of power and the tractive effort was quite satisfactory when the rail was dry, but on frosty or wet rail it was frequently necessary to apply sand by hand. We experimented with sanders but lacked the facilities to make any that would work. The short platform back of the cab was objectionable in that it did not leave sufficient room for men and tools. The same objection applied to the ballast used, pig iron, which not only cluttered up the platform but had the further drawback that it shifted in case of derailment or collision.

In the light of our experience I should now purchase a truck for this sort of work to meet the following general specifications:

Capacity—Not less than 2½ tons.
Motor—4¾x5¾ in. or larger.
Wheels—(*a*) Light cast iron with M.C.B. flange for use on the rails. (*b*) Wood wheels with solid rubber tire for use on the highway.
Brakes—18 in. diameter by 3½ in. wide, or equivalent.
Cab—All steel, weatherproof, with special attention to preventing the admission of carbon monoxide from the exhaust while backing up.
Platform—3 in. plank. Length back of cab to be at least 10 ft.
Ballast—Should be reinforced-concrete flat slabs in units not too heavy to handle. Thickness should be sufficient to load the truck to capacity while making a flat bed covering the platform.
Top—A light, removable top should be provided to protect the

men in bad weather, with plenty of glass in the back end to permit the operator to have a good view to the rear.

Water Cooling—While backing up the fan is almost useless, even if the direction of rotation is reversed by crossing the belt, because the cab shuts off the air from passing around the motor. At least double the water capacity should be provided by an auxiliary tank located, perhaps, back of the cab.

Sanders—Efficient sanders are very important. They should be designed to deliver sand freely to the rail either ahead of or behind the rear wheels as required, and controlled from the driver's seat. The sand boxes should be located immediately over the rear wheels to give a free fall. A sand drier, to be located at the reloading point, should be part of the equipment.

Couplers—The attachments for coupling the truck to the industrial cars should be built from not less than ½x2½-in. strap iron and thoroughly braced. As they hang low, they should be easily removable so that the truck may be used on the highway.

Whistle—The ordinary "squawker" is not sufficient. An exhaust-gas whistle, a siren or a horn of the Strombos type—something giving a loud and compelling warning—should be used. A truck cannot stop a trainload of rails in a moment, and with the best of horns, brakes and sanders the danger of colliding with automobiles at road crossings is great.

Speed—The truck used had a control to limit the speed to 18 m.p.h., although it is suspected that the truck driver often coasted down the hills much faster than this. For better track a faster speed would be desirable.

Transmission—An auxiliary hook-up must be provided to give a full range of speeds in either direction. This consists of an extra set of gears with a shifting lever in the cab. This shifting lever should lock positively in either forward or reverse position.

Turntable—As an alternative to the auxiliary hook-up, a lifting device, operated by the motor or by a crank, may be installed under the center of gravity of the truck, this device to be so designed that the truck may be rotated 180 deg. after being raised until the wheels clear the rail. From the standpoint of safety, comfort of the truck driver and speed of operation such a device would be highly desirable. It is entirely practicable, being in use on at least one of the Dodge inspection cars of the Union Pacific.

Industrial Cars Built for the Job

The proper design of the small cars that carry the rail to the loading point is as important as the design of the truck used to haul them. The cars used were built after plans drawn by the writer. They proved to be ideal for the purpose and would require changes in only a few minor details of their design if the design were to be used again.

It will be seen from Fig. 2 that each car consists of two light steel trucks connected by a removable I-beam reach bar. The distinctive feature of this rail car is the absence of any platform, permitting the rail to be loaded on the 6-in. I-beam bolsters, the tops of which are only about 11 in. above the top of the track rails, and also permitting the passing of a chain under the rails for lifting them onto standard equipment. The reach bars first used were 3-in. I-beams, but this size was found to be rather light, particularly on bad track, where some derailments are inevitable. A few 4-in. beams were used for replacements and were more satisfactory. The reach bars used to connect the trucks of each car and those used to connect one car with another were identical and of such length as to space the trucks 17 ft. center to center and the cars, therefore, 34 ft. center to center.

TRAIN OF EMPTIES GOING OVER A TYPICAL BRIDGE

One other feature of these trucks is the ease with which they are repaired. When they get into a wreck, a little work with a torch and a sledge will put them back into shape. We finished the job with the same twenty trucks with which we started, and they were still in good shape, although their beauty was somewhat marred. Had the wheels been 1 in. wider, some derailments and delays would have been saved. Pressed-steel wheels would have been lighter than the cast-iron wheels we used, but it is believed they would not have stood up. We did not break a wheel or an axle, although the nominal capacity of 6 tons per car was frequently exceeded and although many derailments occurred under load. Had these trucks been much heavier, they could not have been readily lifted on and off the track, and had they been much lighter, they would not have stood up under service.

Other Equipment—The only other equipment used on the work was a 40-ft. stiff-leg derrick and a gasoline hoist. The derrick proved to be of about the right size, and the hoist was entirely satisfactory. When we first started, we used a gasoline crawler crane to lift the rails onto the industrial cars. This crane saved from four to six men, but lost, from delays, cost of gasoline and higher cost of operator, more than it saved. Besides, it was too heavy for some of the weaker bridges and dangerous in operation because, while traveling over the ties, the rails it carried were tossed about in a terrifying manner. It was hard to get men to play cowboy to these bucking rails and guide them onto the cars. Then, too, the particular brand of crane we used was hard to steer and continually got off the ties and buried its nose in the mud. Even if properly designed, it is doubtful if a crawler crane is profitable for this sort of work. With small, low cars such as ours, men with tongs can load rail so fast that it is hard to believe any machine could equal their speed.

As to small tools, we had, of course, the usual comple-

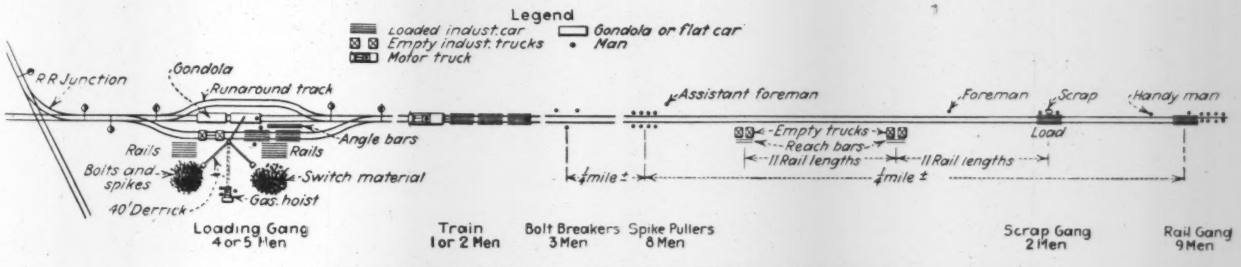


FIG. 1—OPERATING DIAGRAM FOR TRACK DISMANTLING

ment of rail-tongs, sledges, spike mauls, track chisels, wrenches, claw-bars, etc. The writer designed a special tool to cut the bolts. There were about 233,000 of them to be cut, which seemed a formidable task. The bolt cutter worked perfectly, the only fault with it being that we could break the bolts twice as fast with a sledge. We flirted with the idea of cutting bolts with a torch, but the writer is satisfied that this would prove more expensive. After a man gets proficient he can break 90 per cent of the bolts with from two to five blows of a heavy sledge. Only a few of the bolts have to be removed by splitting the nut with a track chisel. We had both $\frac{7}{8}$- and $\frac{3}{4}$-in. bolts, the former, strangely enough, breaking the easier, probably because the nuts were tighter. The only bolts hard to break are the loose bolts. Also, of course, the colder the weather the easier the bolts will snap, for which reason in hot weather it is advisable to have the bolt breakers start work at daybreak, several hours ahead of the rest of the gang.

Organization

Reference to the operation diagram, Fig. 1, shows that the standard gang consisted of about 31 men as follows: One foreman, one sub-foreman, one truck driver, nine rail loaders, two scrap men, eight spike pullers, four bolt breakers and five men reloading material at the junction. This distribution is for light rail. For loading 85-lb. rail four more men are needed on the rail tongs but not so many pulling spikes and breaking bolts, because the speed of loading is usually slower. Naturally there was some variation in the size of the gang from day to day. Of the nine men on the rail gang, one acted as a sort of straw boss, checking the number of rails loaded and spotting the car in the proper position to receive the next rail. The rail gang is the infantry of the wrecking army; the function of all of the rest is to prepare the way so that they may advance as fast and as continuously as possible.

All these men lived at the town where the rail was being reloaded, riding out to the end of track each morning and returning on the last trainload of rails at night. In the morning, when the truck reached the end of track, the rail gang at once lifted one of the rail cars on to the track, coupled the train and commenced loading. Such empties as had been brought out were hauled to the spots where they would be needed and set off in the clear. The spike pullers then started where they had left off the night before and the motor was returned to the rail gang and coupled up to the partly loaded car. As soon as a train of three or four cars had been loaded, the truck went to the reloading point, where it delivered its load and picked up such cars as had been emptied, returning immediately to the end of track, where the spike pullers set off the empties. By this time another train of rails would ordinarily be loaded, to which the truck would couple and again start for the reloading point. This sequence of operations was repeated until the gang knocked off for the night.

When the end of track was more than 3 or 4 miles out, the rail gang got very little help from the truck in the way of keeping the loaded cars out of the way or spotting the partly loaded cars; therefore they had to be pushed ahead by hand. Where the reloading points are far apart, a second truck may be an economy, but, of course, the second truck cannot function unless there is a siding between the end of track and the junction point. We had a light truck that we occasionally used for this purpose, and this helped somewhat when the haul was 12 miles or more. It was ordinarily used by the track repair gang, 10 to 30 miles in advance, and was not often available. With plenty of small cars and with sanders on the truck, a second truck is not needed.

The whole aim and object is to keep the rail gang loading as continuously as possible. On light rails and with the sort of industrial cars described eight men can easily load four cars of 22 rails each per hour. If not delayed and assuming nine hours' time at the front, this would mean more than 2 miles per day. Actually we never loaded more than 1.6 miles, principally because we had not provided a sufficient number of small cars and because of the bad condition of the track and the slow truck speed this condition made necessary. Anyone who contemplates wrecking in this manner cannot be too strongly urged to provide plenty of cars. If we had had five more, at a cost of about $1,000, I am satisfied we would have saved from five to six times that amount.

The number of cars needed depends on the speed of the truck, the maximum length of haul and the weight of rail, since the weight per rail determines the number that can be loaded on a car of a given capacity. On some jobs with good track and short hauls ten cars would suffice, whereas on others as many as twenty might be needed. The point is to figure on maximum rather than average haul and to be very liberal in the estimate. Delays in hauling are inevitable, but they are of little consequence if there are enough empties at the front to keep the loading gang going until the truck returns with more.

The plan of the rail car shows the method of loading the rail. It is important to load carefully in order to keep the rails from shifting in transit. It will be noted

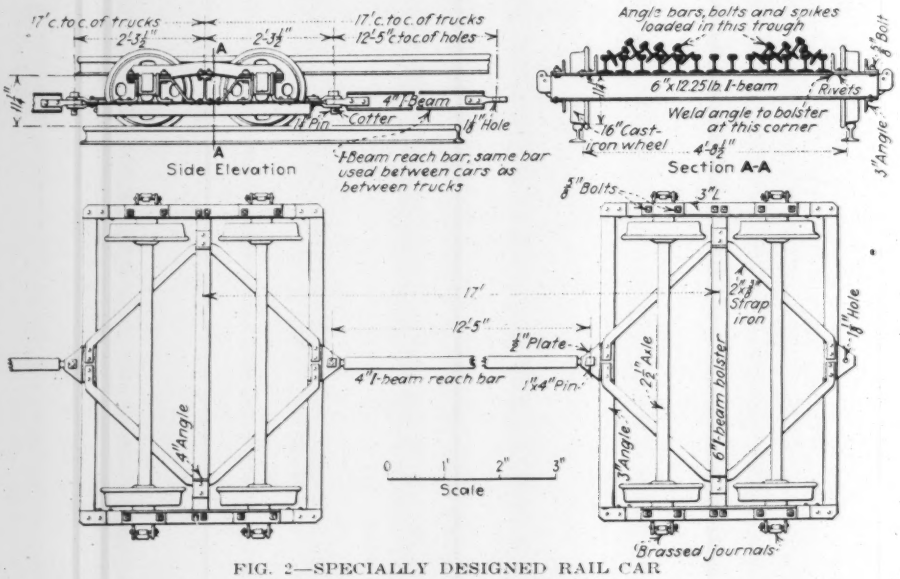


FIG. 2—SPECIALLY DESIGNED RAIL CAR

that the rails are piled higher on the side, leaving a trough in the center, in which are loaded the angle bars, bolts, spikes and switch material. Some do not attempt to salvage bolts and spikes, but this is a mistake. If the outside spikes are left in, four men less will be needed on the spike gang, but the rail cannot be loaded so fast and the entire gang of 31 men is delayed; besides, a lot of scrap is lost. We sometimes had to leave in these outside spikes when we were short of men, but it is probable that this does not pay. Spikes and bolts will run about 2½ tons to the mile and the additional cost of picking them up is less than their value. The scrap men assembled this small stuff and also the angle bars at points where they could be loaded with little or no delay to the rail gang. It might have been better had we provided ourselves with a sufficient number of strong containers about the size of powder cans and assembled the scrap in these cans instead of in loose piles. This would have facilitated unloading at the junction point.

In moving from one loading point to another it is better, even if the distance is as much as 100 miles, as it may be if a circuitous route has to be followed, to load the equipment on the small cars and, using the truck as a locomotive, detour over other railroads rather than to ship the equipment by freight. When we detoured, we could ordinarily take down and load the equipment and get to the next town in one day and set up the next, sometimes even bringing in a little rail the same day. When we shipped by freight, we lost from one to five days additional. The cost of freighting and detouring is usually about the same, although the latter is sometimes considerably cheaper, especially if the railroads can be induced to cut the ordinary charge of $1.50 per train-mile.

Advantages of Wrecking by Truck

It has no doubt occurred to the reader that the method of wrecking described here calls for a double handling of the rail. Of course, this is quite true, and this second handling offsets some of the savings effected. However, the writer is convinced that the net cost per ton using a truck and small cars will be considerably less than using a locomotive and flat cars. The advantages, as the writer sees them, are:

1. A motor truck and small cars will operate slowly over track from which nearly all the bolts and spikes have been removed. On 85-lb. rail we took out all the bolts and spikes for a quarter of a mile in advance of the rail gang. On 56-lb. rail we left in only one bolt per joint and three or four spikes on the outside of each rail. This leaves the field clear for the rail loaders. With a locomotive and flat cars the spike pullers, bolt breakers and rail loaders are too close together and in one another's way, thus causing considerable delay.

2. The operation of tearing up and loading rail is more nearly continuous, hence the speed of wrecking is greater than when a locomotive is used. The rail gang is idle, or nearly so, while the locomotive is taking the loaded flat car to the nearest siding. Then, too, anyone who has had much work-train experience knows of the maddening propensity of the locomotive, just when it is most needed, to require water with the tank perhaps 30 miles away.

3. The train crew and coal cost of a work train is far higher than the pay of a truck driver and the cost of gasoline, so much so that this will nearly if not quite offset the cost of the reloading crew. Also, the use of a locomotive requires the continued maintenance and operation of the coal and water stations.

4. It is easier and faster and takes fewer men to load rail on small cars with the bolster only 11 in. above the track rail than to load on flat cars. Men carrying rail with ordinary tongs need give only a very slight lift to land the end of the rail on the bolster of the rear truck, after which it is easily slid along into place.

5. If rail is to be sorted into first- and second-class relayers and scrap, it will have to be rehandled. Using small cars, the reloading gang can do this sorting at no extra expense. With a locomotive, the cost of sorting, if required, may be almost as great as the cost of reloading.

Cost Data

A fairly accurate record was kept of the labor cost of wrecking the Kansas City Northwestern, but I hesitate setting out the figures, because they do not give, even approximately, a fair idea of the cost of salvaging by truck. This for three reasons. First, although the cost of repairing the track, which was done by another gang of from five to nine men, was apparently segregated, actually a considerable part of the labor cost charged to wrecking was really due to track condition. The picking up of derailments due to spread rail and the delays from such causes were charged to wrecking, but no such charges would have occurred with the track in even fair condition. Many bridges were burned out, and this in some cases prevented rail from being hauled to the nearest junction. Always the condition of the track forced a slow truck speed that added materially to the cost. Second, the cost was much increased by our failure to provide enough small cars and to some extent by the lack of sanders on the truck and other small faults in truck design. Third, our men were paid a considerable bonus, amounting at times to about $30 per man per month, which probably increased the cost per mile. These things should all be borne in mind in comparing the labor cost of the work as done by us with the cost of wrecking by other methods.

135 MILES OF 56-LB. RAIL TRACK

Nature of Work	Cost Per Mile	Cost Per Gross Ton
Tearing up and loading rail	$126.00	$1.38
Hauling by truck	13.00	.14
Reloading on flat cars	31.00	.34
Miscellaneous, including moving and setting up	15.00	.17
Total labor cost	$185.00	$2.03

Costs per gross ton are figured on a weight of 54½ lb. per yard for the rail plus the weight of angle bars and spikes, or 91.1 gross tons per mile. Laborers were paid 35 cents per hour plus a bonus for all over 3,500 ft. of track loaded per day, which made their pay average about 40 cents per hour.

In addition there were a gasoline cost for truck and hoist, amounting to $4 per mile, and the interest, maintenance and depreciation on the equipment, amounting to $22 per mile.

On heavier rail the cost is more per mile but less per ton. Our costs for the heavier rail have not been shown here, because it was mostly loaded with the crawler crane and also because we complicated the costs at first by experimenting with wrecking the wooden bridges, which, it turned out, could not profitably be done by the wrecking crew.

Measures Proposed to Distribute Flow Over Niagara Falls

International Niagara Board Proposes Works to Distribute the Flow in Rapids Above the Falls

MEASURES that should be taken in the immediate future to improve the scenic effects at Niagara Falls and at the same time make possible the diversion of additional water for power purposes were outlined in a summary of an interim report of the Special International Niagara Board which was made public by the State Department on Jan. 20. As the document given out by the department was a summary of the report and as certain details of the proposals contained therein were not clear, publication of it in *Engineering News-Record* was held up while an effort was made to get access to the full report in the hope that it might give more details and possibly some drawings of the proposed remedial works. Inquiry at the Department of State has revealed the fact that the full report is not to be made public at this time. Consequently, as the report is of importance as being the first in which the plans for improving Niagara Falls which have been under discussion for some time are given official recognition, an abstract of it is given herewith. EDITOR.

Conditions at the Falls—The board's investigations demonstrate that three principal conditions have been developing which have reacted directly upon the scenic beauty of the Falls: (*a*) The recession upstream of the crestline, (*b*) the culmination of a cycle of abnormally low runoff years in the Great Lakes system, (*c*) the withdrawal of water for navigation, sanitary and power purposes.

Recession—Considering first the recession of the Canadian or Horseshoe Falls, an exhaustive study of the geological structure of the falls and gorge, in conjunction with an analysis of the rate and character of the recession of the crestline as disclosed by surveys made from time to time from 1764 to 1927, leads the board to conclude that there is no danger of the Horseshoe degenerating into a cascade or destroying itself by cutting a deep "notch." On the contrary, there is every reason to believe that the active part of the Horseshoe will broaden out and the crestline lengthen in graceful curves.

The board's investigations, made with the aid of competent geologists, show a mean rate of recession of the crest of the active part of the fall of 3.7 ft. per year since 1842 and of 2.3 ft. per year since 1906, indicating that the Horseshoe is now cutting back at a decreasing rate and that the rate will continue to decrease. There are four reasons for this:

1. For some years the recession of the crest has tended to move upstream along the course of two diverging deep water channels on either side of a central shoal, with the result that the "toe" of the Horseshoe is growing broader rather than cutting into a single "notch."

2. The floor of the upper rapids and the crest of the fall is a very hard and thick stratum of limestone. Recession occurs through the falling of large blocks of this limestone as it is undercut through the wearing away of softer underlying strata. The thickness of this upper stratum increases from about 78 ft. at the present crest line to about 130 ft. at the head of the upper rapids. As the crest moves upstream the increased thickness of this stratum will decrease the rate of recession.

3. As the falls recede the active part of the crestline will increase in length and the flow per unit of crest will decrease. This natural thinning out of the flow will decrease the rate of recession.

4. During recent years a large part of the flow has been diverted for power purposes. This fact has probably decreased the rate of recession.

Remedial Works—As the falls are in no danger of "committing suicide," the board has rejected all plans involving elaborate works in the main part of the rapids as unnecessary to accomplish the desired results and as destructive of some of the principal natural scenic effects.

The type of construction considered by the board as best suited properly to rewater the flanks of the Horseshoe is a combination of excavations and submerged weirs carried from the shores near the flanks into the adjacent main currents only far enough to accomplish the desired deflection of water to the flanks. This plan is susceptible of progressive extension upstream and into the rapids to the extent required to mask the effect of any reasonable additional diversions that may be agreed upon.

Initial Works Recommended—The initial remedial works proposed consist of the removal of exposed shoals, in conjunction with the construction of submerged weirs lying diagonally and irregularly across the current, with incidental and co-ordinated excavation designed to deflect water from the heavy currents to the north and south of the central shoal

The lack of volume of the American falls and rapids and of the flow around Three Sister Islands can be remedied by raising the level of the Grass Island Pool approximately 1 ft. at low stages by means of an irregular submerged weir or weirs located upstream from Goat Island. Such construction will be quite inconspicuous, probably resulting in nothing more than a very slight ripple or rapid. It could be of rubblemound construction, submerged so deeply as to create no obstruction to the flow of ice.

Cost Estimates—While the cost of works of the progressive character recommended cannot be foretold with certainty, estimates have been prepared with as much care as the nature of the work permits and are submitted as follows:

For works at the United States flank of the Horseshoe Fall	$300,000
Changes and contingencies	150,000
For works at the Canadian flank of the Horseshoe Fall	200,000
Changes and contingencies	100,000
For works in the Chippawa-Grass Island pool	800,000
Changes and contingencies	200,000
Total	$1,750,000

Conclusion—The board is of the opinion that it is most desirable that the measures for providing such a substantial betterment of the spectacle should be inaugurated at an early date.

Composition of the Board—The special international board which has these Niagara investigations under way consists of two members for Canada, J. T. Johnston, director of the Dominion Water Power and Reclamation Service, Department of the Interior, Ottawa, and Charles Camsell, Deputy Minister of Mines, Ottawa; and two members for the United States, Major DeWitt C. Jones, district engineer at Buffalo of the United States Corps of Engineers, and Dr. J. Horace McFarland of Harrisburg, Pa., past-president, American Civic Association and chairman of the Fine Arts Commission of the State of Pennsylvania.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Canadian Engineers Gather in Montreal For Annual Meeting

Plans Laid to Increase Activities of Younger Men—Research in Concrete Discussed

(Engineering News-Record Staff Report)

WITH an unusually large attendance, somewhat over 600, the Engineering Institute of Canada held its 42nd annual general and general professional meeting in Montreal, Feb. 14-16. The first day was given over to the annual business meeting of the society, including the presentation of reports of council and standing committees and to the discussion of proposed amendments to bylaws; technical sessions occupied largely the second and third days.

Unlike many engineering society business meetings, discussion was active throughout both sessions on the first day. It was due in large part to the great interest taken in the proposed amendments to the bylaws for the purpose of increasing the dues of members, changing the method by which the council shall elect members, and giving the annual general meeting greater power in the matter of amending proposed amendments.

Interest in Younger Men

Special interest in students and junior members was shown by the society in a number of actions taken throughout the year as shown in the report of the council. One of the amendments to bylaws now to be put to letter ballot is one providing for the organization of student sections. Some such sections have been organized but so far have been without official recognition. To stimulate interest of students and juniors, the Institute has authorized the establishment of five prizes: one each in three of the zones and two in the fourth zone, one of the latter for an English-speaking student or junior and one for a French student. These prizes have been named in honor of deceased presidents of the Institute. They will consist of books or instruments to the value of $25, suitably bound or engraved.

The award to corporate members of a gold medal to be known as the Sir John Kennedy Medal also was authorized, when occasion warrants, as recognition of outstanding merit in the profession or noteworthy contribution to the science of engineering.

In recognition of a fund established in 1923 by the then living past-presidents, a prize in cash or books to the value of $100 also was authorized, to be awarded for the best paper contributed by members of any grade during each year.

Concrete in Alkali Soils

Chief among the committee reports was that of the committee on deterioration of concrete in alkali soils. This committee has been carrying on its studies since 1921 and has spent, in all, nearly $48,000 in laboratory and field work. It is now without funds to continue the studies and as the National Research Council, the largest contributor to the work of the committee, is at present urging the government to extend its activities, the committee feels that continuation of the studies should be turned over to the council, the committee to continue in an advisory capacity, if desired. A motion to this effect was approved.

The advisability of adopting standard contract forms, similar to those adopted by the Canadian Construction Association at its recent meeting, was discussed and a committee appointed to report to council on the subject.

At the close of the annual meeting the scrutineers reported the election of Julian C. Smith, vice-president and general manager, Shawinigan Water & Power Company, to be president of the Institute, and of A. J. Grant, W. O. Mitchell and F. O. Condon to be vice-presidents.

Technical Sessions

Technical sessions were held Wednesday morning and Thursday. Wednesday afternoon was given over to the inspection of engineering works about Montreal, including the Montreal harbor bridge, the city's new intercepter

(*Continued on p. 335*)

A.S.T.M. Committees to Meet in Washington March 20-23

Twenty-nine committees of the A.S.T.M. and certain joint committees will hold meetings in conjunction with a four-day group meeting in Washington, D.C., March 20-23. The committees which will meet are those on steel, wrought iron, cast iron, heat treatment of iron and steel, magnetic properties, magnetic analysis, copper wire, corrosion of non-ferrous metals and alloys, brick, lime, gypsum, preservative coatings for structural materials, zinc coating of iron and steel, road and paving materials, coal and coke, bituminous waterproofing and roofing materials, testing of wire screen cloth, thermometers, naval stores, natural building stone, and five sections of E-1: editorial, chemical composition, methods for density, plasticity and consistency, coarse screens and sub-sieve sizes; E-5 on standing committees and cast-iron pipe.

Buildings Fall Into Subway Excavation, Killing 2 Workmen

Apparently Sound Rock Supporting Underpinning Shears Off on New York Project

TWO men were killed Feb. 15 when three two-story brownstone front buildings over the recently uncovered tunnel excavation for the new 53rd St. subway from Manhattan to Queens, New York, collapsed. The collapse was due to a slight shifting of what had appeared to be sound rock, upon which underpinning of the buildings rested, a large section of which sheared off, dropping the buildings into the excavation. The two men who were killed failed to hear the warning given by the contractor's general foreman and were caught in the debris. These men were in the buildings, all workmen beneath the structures receiving the warning in time to escape. Purchased by the Board of Transportation because of certain advantages over securing easement rights and scheduled for ultimate demolition, the buildings were being used by the contractor for his carpenters' and electricians' shops and as compressor plants and warehouses.

The three buildings which collapsed were situated in the middle of the block between 52nd and 53rd Sts., where two tracks from the Eighth Ave. line dip down and turn out into the 53rd St. tunnel. The subway beneath the buildings had been built as tunnel and the top was being removed as required at this point so as to preclude any future building being erected on the rock over the subway. The tunnel cut was 40 ft. deep and the underpinning started from a ledge about 15 ft. above the bottom of the cut. It consisted of concrete piers on each side of the cut between which spanned I-beams adequate in every way to carry the loads of the buildings. It is the belief of the engineers of the Board of Transportation that a corner of the ledge slid into the cut along a concealed mud seam, carrying with it two of the piers and the underpinning. The building wall directly above collapsed and pulled the other buildings after it.

No negligence in providing proper underpinning is charged to the contractors, Heyman & Goodman.

American Welding Society to Meet April 25-27

The tentative program has been announced by the annual meeting of the American Welding Society, to be held in New York April 25-27. It calls for reports by the various committees and discussion on the progress made.

James H. McGraw Awarded Bok Medal for Service to Advertising

JAMES H. McGRAW, president of the McGraw-Hill Publishing Company, Inc., was awarded the Gold Medal for Distinguished Contemporary Service to Advertising at a dinner at the Harvard Business School Feb. 17. The medal was founded by Edward Bok in 1923, together with a number of prizes to be awarded annually for excellence in the presentation of advertising copy. The signal award to Mr. McGraw was the result of his lifelong service in the upbuilding of higher standards in advertising in the business press of the country. In the absence of Mr. McGraw in the South his acknowledgment of the award was read by Malcolm Muir, vice-president of the McGraw-Hill Company.

Mr. McGraw was born in Panama, Chautauqua County, New York, Dec. 17, 1860. He entered the publishing business from the principalship of an upstate school. He is president of the largest business publishing organization in the world. It has grown from one paper, which was purchased by Mr. McGraw in 1888, until today there are published twelve engineering and industrial publications in New York, one in San Francisco and one in London. Mr. McGraw is also chairman of the McGraw-Shaw Company, which publishes industrial papers in Chicago, and of the McGraw-Hill Book Company, which publishes technical and business books. He is a member of many engineering, business and scientific organizations.

Following are extracts from Mr. McGraw's address in response to the award.

Advertising is a challenge to soundness. It drags an institution into the limelight. It exposes it to examination and to criticism of its claims. Its defects are sure to be exposed.

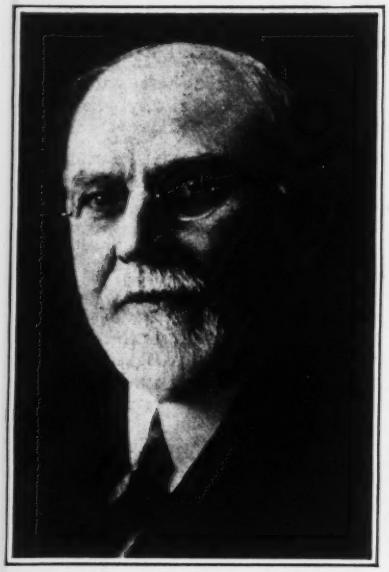
For businesses with products that match the needs of the times, advertising is a beneficent instrument; for those with products that have no rightful market claim, advertising is either corrective or fatal.

And to soundness of product or service, there must be added soundness of marketing method, if advertising is to be an effective instrument of prosperity. . . .

We, therefore, have a grave responsibility toward those to whom we offer advertising counsel. Effective advertising must be reared on two sturdy foundations: The first, a product or service which meets existant or unexpressed needs of the market; the second, a waste-free marketing plan for reaching responsible buyers.

But sound advertising is a remedy for faltering business not alone in spurring the profitable filling of buyers' present wants. We have come to see that the very development of our social structure depends upon the rapid enlargement of needs and the introduction of new products.

Through the adoption of production economies, principally the greater use of power and the fruits of research, established industries constantly reduce the numbers of their employees per unit of product. The surplus workers thus thrown off by



JAMES H. McGRAW

older industries must be absorbed into new ones, otherwise we shall have widespread unemployment, lowered standards of living, suffering, discontent. It is the rôle of consumer advertising quickly to introduce new products to a mass market, and thus create new demands for surplus labor. The automobile, the motion picture, rayon and a score of like products could not have been made servants of our common life so quickly had it not been for the penetration of advertising into every nook and corner of this country and through every purchasing level. . . .

In thus adapting advertising to its destined sphere of usefulness, we of the business press have endeavored to do our share. The consumer medium creates consumer demand and directs the consumer to the dealer. Our function is to move goods from industry to industry, and from maker to distributor. To no small degree, industry's profits are measured by economies in those many interindustry and intermerchant movements which lie back of the final sale.

The very essence of the business press is an intimate relationship with an understanding of the industry or trade served. The significance of its editorial counsel finds reflection in the use of its advertising pages. Over interindustry transactions the industrial paper throws an effective net, tapping in for every industry on its supply channels and affording the supplier a direct contact with his market. The buyer uses the industrial paper as a tool of operation, making it the channel through which he selects the materials and equipment for the efficient manufacture of his product.

It is evident, therefore, that the industrial division of the business press has an important beneficial effect on the profit margin. Its reading pages are a textbook of economy in manufacture; its advertising pages, a textbook of equipment for doing jobs at lower cost. Through reading and advertising pages, then, it conducts to the lowering of producers' costs on consumers' products. Thus it tends to widen the profit margin. At the same time, through production economies, it gives the public continually greater values.

In its trade division, the business press is friend and counselor of distributor and dealer. It is a powerful instrument in developing producer-distributor relationships that smooth the flow of goods to the public. It transmits evidences of sustained demand, introduces new products quickly, demonstrates the power of quality. Through the trade paper is established a community of interest among manufacturer, distributor and dealer. They become co-operating elements by which consumer wants are filled with desired merchandise of known quality, with prices reflecting speedy turnover.

That the advertising world is fully aware of the importance of the business paper in serving industry, trade and the public, as an ally of the consumer medium, is indicated by the award of this medal, this high honor, to a business paper publisher tonight.

Deepening of Harbor at Montreal Is Planned

Submerged dams may be constructed in the vicinity of the Sorel Islands or at other strategic points on the St. Lawrence River between Montreal and Three Rivers in order to increase the depth of water in the ship channel, and more particularly in the harbor of Montreal. During the course of a recent interview, Alex Johnston, Deputy Minister of the Canadian Department of Marine, explained that many suggestions for improving the river had been received during the last twenty years and admitted that there is a possibility of damming the stream in such a way that navigation would not be impeded. He expects that the Minister of Marine will be in a position to announce a fairly definite program in the near future, as plans are now being drawn up.

The ship channel has been materially improved and much work is still being undertaken. All curves have been widened, and further dredging will result in the waterway being straightened at other points between Montreal and Quebec. During the 1927 season 2,158,370 cu.yd. of material was removed from the channel between Montreal and Quebec.

New York Power Authority Proposed in Bill

Senator Downing, of New York City, on Feb. 17 introduced in the state Senate Gov. Smith's bill creating a state water-power authority. By its terms three commissioners would be appointed by the Governor with the consent of the Senate. They would serve without salary, but $100,000 is appropriated by the terms of the bill for traveling expenses and salaries of assistants.

The bill calls for a report to the Governor and the Legislature by Jan. 15, 1929, on a plan whereby the state may develop its hydro-electric resources and sell the energy. It is declared in the bill to be the policy of the state to preserve forever its national water-power resources.

City Planning Prominent At Twentieth Meeting Of Wisconsin Engineers

City planning, considered from different points of view, was the prominent subject at the twentieth annual meeting of the Engineering Society of Wisconsin, held at Madison Feb. 16 to 18. In a paper on "City Planning for Small Cities," Jacob L. Crane, Chicago, outlined the advantages to the municipality and the people in having a definite plan for systematic development. Prof. L. S. Smith emphasized these advantages but pointed out the many difficulties in securing the adoption of a plan and then getting it carried into effect, one great difficulty being to keep the plan alive and prevent it from being pigeonholed and forgotten.

A paper on "Play Spaces as Civic Responsibilities," by Gilbert Clegg, city playground engineer of Milwaukee, touched another phase of the same general subject, especially as to providing funds and dealing with the "nuisance factor" as affecting property which fronts on a public playground. A third paper, by Clifton Williams, assistant city attorney of Milwaukee, discussed the legal aspects of city planning. He dealt largely with property rights, but Professor Smith pointed out that where these are in conflict with human rights the latter must be superior, and he cited court decisions supporting this view. He also advocated education in city planning in the public schools, as in Chicago, where pupils get a real idea of the Chicago Plan and its purpose.

The new sewage-works for Madison were described by E. E. Parker, city engineer. These include Imhoff tanks, sprinkling filters, clarifiers and sludge-drying beds. At the new sewage-works at Antigo, Wis., as described by Jerry Donohue, consulting engineer, Sheboygan, Wis., in a paper on "Separate Sludge Digestion," the gases are utilized by burning them to heat the buildings. Professor Van Hagan presented a committee report on the licensing of engineers and surveyors.

Outside of the usual line of subjects was a paper on "Acoustics of Public Buildings," by J. P. Schwada, city engineer of Milwaukee, describing studies in certain large halls. An illustrated talk by Dean F. E. Turneaure, of the college of engineering, University of Wisconsin, described his recent tour in South America. In a lengthy address on floods and flood protection in the Mississippi Valley, by Daniel W. Mead, consulting engineer, a point emphasized strongly was the necessity of having some competent and responsible head in permanent charge of any project that may be adopted.

Officers elected for 1928 include: President, Joseph P. Schwada, city engineer of Milwaukee; vice-president, L. F. Van Hagan, professor of railway engineering at the University of Wisconsin. The secretary is Charles I. Corp, hydraulic laboratory, University of Wisconsin, Madison, Wis.

Electric Railway Journal Wins A.B.P. Award

The award set up during the past year by the Associated Business Papers, Inc., to the business paper contributing the most definite and outstanding service to the field with which the publication is connected has been won by *Electric Railway Journal*, one of the McGraw-Hill publications. Announcement of this honor was made at a combined meeting of the National Conference of Business Paper Editors and the Educational Committee of the Associated Business Papers, Inc., held Feb. 10 in Boston.

Briefs were submitted in this contest by 21 business publications serving as many different industries. The Associated Business Papers, Inc., which established the award and under the auspices of which the contest was conducted, includes in its membership 126 of the leading business papers published in the United States and Canada. The jury of award consists of Dr. Julius Klein, director of the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.; James W. Brown, publisher of *Editor and Publisher;* David Beecroft, vice-president, Chilton Class Journal Company; William M. Richardson, chairman, business paper committee, American Association of Advertising Agencies, and W. A. Wolff, former president of the National Industrial Advertisers' Association.

Canadian Engineers Meet

(*Continued from p. 333*)

sewers and the plant of the Dominion Engineering Works.

Papers of special interest to civil engineers were: three on features of the Welland Canal: first, The Chippawa Creek Siphon Culvert, by A. J. Grant, engineer-in-charge, Welland Ship Canal; one on the lock gates, by F. E. Sterns, designing engineer, and a third on the movable bridges, by M. B. Atkinson, structural engineer; two papers on the Royal Bank Building in Montreal, one on the foundation by C. S. Proctor, consulting engineer, New York, and one on the steelwork, by R. M. Robertson, structural engineer, Dominion Bridge Company; a paper on electric heating of rack bars in hydro-electric plants, by C. R. Reid, superintendent of generating stations, Shawinigan Water & Power Company; and four papers on concrete. Two of the latter papers were appendices to reports of the committee on deterioration of concrete in alkali soils, presented in the technical discussions rather than at the annual business meeting earlier in the week; a third was a related paper on the effect of steam treatment of portland cement mortars on their resistance to sulphate action, by T. Thorvaldson and V. A. Vigfusson, of the University of Saskatchewan, and the fourth, a paper entitled "The Requirements for a Durable Concrete as Observed From Structures in Service," by R. B. Young, testing engineer, Hydro Electric Power Commission of Ontario. The three papers on the effect of alkali on concrete were presented by C. J. Mackenzie, dean of engineering, University of Saskatchewan, committee chairman.

An event of special interest was the presence of the Governor-General of Canada, Lord Willingdon, as the guest of honor, at the annual dinner of the Institute. In speaking of the activities of engineers, Lord Willingdon stated that he hoped to see the time when all great engineering works in Canada would be directed by Canadians and financed from within the empire.

Julian Smith, Many Years With Shawinigan Company, Heads Canadian Engineers

Julian C. Smith, vice-president and general manager of the Shawinigan Water & Power Company, Montreal, Que., was elected president of the Engineering Institute of Canada at its recent meeting in Montreal. Mr. Smith is a native of Elmira, N. Y., and a graduate of Cornell University in 1900. A year after graduation he became an assistant engineer in the firm of Wallace Johnson, consulting engineer, Niagara Falls, N. Y., and the following year went to Shawinigan Falls, Que., to take charge of electrical and mechanical installations and design for the same firm. This work at Shawinigan Falls resulted in his establishing a connection with the power developments at that point which has continued since that date. In 1903 Mr. Smith became operating manager of the Shawinigan Water & Power Company, in 1905 general superintendent in charge of design and construction and in 1908 chief engineer in charge of the power developments at Shawinigan Falls and Cedar Rapids. In 1916 he was elected vice-president and general manager in charge of all engineering and construction of the Shawinigan companies.

Bill Authorizes Port Authority to Build Toll Tunnels

To authorize construction and operation of one or more tunnels by the Port of New York Authority a bill has been introduced into the New York State Senate. The bill would authorize building of tunnels (the New Jersey Legislature concurring) for traffic of any description, south of Sixtieth St., Manhattan, to a point or points in Hudson County, New Jersey. Authorization is given the Port Authority to establish such rules or regulations as are considered necessary and such rentals, charges or tolls as are considered necessary for efficient operation and maintenance.

To Improve Status of Engineers in U.S.P.H. Service

A bill designed, among other things, to give the sanitary engineers in the U. S. Public Health Service the same status as that of members of the medical profession in the service is before Congress. The bill (H.R. 11026) has been given the unanimous approval of the House committee on interstate and foreign commerce and is favored by both the President and the Secretary of the Treasury. Similar legislation has been urged for several years past by the American Public Health Association, the National Health Council, the American Federation of Labor, the Chamber of Commerce of the United States and other national organizations.

Support is being given to the bill by committees of the American Society of Civil Engineers and the American Public Health Association, both of which are headed by George W. Fuller, consulting engineer, 170 Broadway, New York City. These committees desire the backing of other engineering societies as well as of individual engineers, through appeal to their respective Congressmen as well as any other Senators or Representatives of their acquaintance. Sponsors of the bill have summarized its more important provisions as follows:

1. Co-ordination of federal health work will be brought about through the detail of officers of the Public Health Service to other departments to co-operate in the conduct of their health activities.

2. Additional divisions in the Hygienic Laboratory are authorized to meet the requirements of public health research. This will permit of some public health engineering research.

3. Public health officers may be assigned to educational and scientific institutions for special studies, and facilities of the Hygienic Laboratory are made available to health officials and other scientists. A national advisory health council will be created representing various branches of the public health profession. Sanitary engineering undoubtedly will be represented on this council.

Flood-Control Discussed by Minnesota Engineers

The seventh annual convention of the Minnesota Federation of Architectural and Engineering Societies was held Feb. 17 and 18 in Minneapolis. The Mississippi River flood-control problem caused the greatest discussion. It was opened with a paper by Lieut.-Col. G. B. Pillsbury, district engineer, U. S. Corps of Engineers.

Super highways and water control problems as related to public and private interests were also discussed. John T. Stewart, consulting engineer of the state Game and Fish Department, St. Paul, read a paper on the latter subject.

New officers elected are: N. W. Elsberg, city engineer of Minneapolis, president; F. A. Wildes, of the state Mining Bureau, vice-president; Prof. A. S. Cutler, treasurer; G. H. Herrold, editor; Katherine Feucht, secretary.

Washington Notes

Senate Committee Calls Hoover On Flood Control; Toll Bridges And Roads Subjects of Hearing

By Paul Wooton
Washington Correspondent

OVER the active opposition of Chairman Jones and several other members of the Senate committee on commerce it was decided by a seven to six vote to call Secretary Hoover before the committee in connection with flood-control legislation. It was contended by friends of Mr. Hoover on the committee that an effort will be made to embarrass him for political purposes. Secretary Hoover is said to hold a different view with regard to local contributions for flood-control work from that of the President and certain members of the Cabinet. It is contended that he is being called, in effect, to bring in a minority report from a Cabinet meeting, an unprecedented procedure. The movement had its origin, it is stated, among those who think the situation in Ohio might be changed were it possible to establish that the President and Secretary Hoover are at odds over a flood-control policy. The committee is scheduled to hear the Commerce Secretary at 10 a.m., Feb. 24.

Highways

The Senate committee on post offices and post roads has reported favorably on the highway bill of Senator Phipps, authorizing $75,000,000 annually for two years for the federal-aid road system and $7,500,000 annually for two years for forest roads and trails. The House committee has concluded hearings on a similar bill, which will be reported in the near future. The committee also reported favorably the amendments of Senator Oddie allowing Western states to concentrate funds on through roads, eliminating the $15,000 per mile limit and authorizing automobile organizations at their own expense to erect federal markers bearing the name of the organization. This latter amendment will be opposed in the House.

Toll Bridges

Representative Denison, of Illinois, appeared before the House committee on roads, urging the elimination of the provision in the present law that precludes the use of federal aid on roads leading up to toll bridges. Thomas H. MacDonald, the chief of the Bureau of Public Roads, and W. C. Markham, representing the Association of State Highway Officials, appeared in opposition to the bill. Mr. MacDonald made the point that the original highway act, which was submitted to each state for approval by its legislature, provided that the highway system was to be free from tolls. It is not fair to the states, which eventually are to take over the bridges, for the federal government to grant franchises when there is no thought that the federal government eventually will take over the bridges. Mr. Markham pointed out that Congress is granting bridge franchises running from twenty to fifty years that are so worded that the states, in taking over the bridges, would be compelled to pay for good will and prospective profits. He called attention to the fact that such bridges are not subject to inspection and that there are no requirements as to maintenance. The Chief of Engineers simply certifies that the structures will not interfere unduly with navigation.

Chicago Metering

The Secretary of War has approved an amendment to the Chicago water-metering ordinance which removes the requirement to place meters on all service pipes to new consumers but which requires the metering of at least 90 per cent of the water service at the average rate of 10 per cent per annum to be completed by Sept. 1, 1935. The district engineer at Chicago reports that the city is considerably behind with the metering program, but with the understanding that it is to be speeded up and carried out faithfully, the War Department is willing to accept the work that has been done as substantial compliance with the requirements of the permit for the diversion of water from Lake Michigan.

New Central South Section of Am. Soc. C. E. Started

Plans initiated to form a section of the American Society of Civil Engineers at Memphis, Tenn., May 8, 1925, which were so tragically interrupted by the "Norman" boat disaster, were resumed Feb. 7. Formation of a Central South Section was authorized at a meeting of 45 members of the society called together to meet Col. Lincoln Bush, president, and George T. Seabury, secretary. All details of the organization were delegated to a committee consisting of N. H. Sayford, vice-president, Morgan Engineering Company; Maj. Stuart C. Godfrey, U. S. Dredging District, and J. H. Haylow, chief engineer, Memphis Street Railway Company. Engineers were present from Arkansas, Mississippi and Tennessee, and the limits of the section will likely cover parts of these three states.

Mr. Seabury outlined the work of the organization, laying stress on the 40 per cent time of the directors in scrutinizing the qualifications of applicants, the care with which the papers are selected and edited and finally the rapid growth which the society has taken in the last few years.

Colonel Bush gave an illustrated talk on the Tunkhannock viaduct built under his direction as member of a firm of contractors for the Lackawanna Railroad.

On the following day a dinner was tendered Colonel Bush and Mr. Seabury by the Engineers' Club of Memphis, the local section of the American Institute of Architects and the Associated General Contractors.

Personal Notes

R. A. WENTZEL, who during 1926 and 1927 was resident engineer on the power house of the Santeetlah development in North Carolina for the Aluminum Company of America, is now in São Paulo, Brazil, as assistant to the chief engineer of the São Paulo Tramway, Light & Power Company, Ltd. Mr. Wentzel, who is a graduate of the University of Maine, was previously employed, in 1925, by the same company on the construction of the Sera development in Brazil.

S. M. WILLIAMS, well known in highway and construction circles, director of the American Road Builders Association and of the Highway Industries Association, has been appointed manager of the Highway, Public Works and Railway divisions of the Associated General Contractors of America. This new branch, embracing engineering construction, was created at the recent convention of the A.G.C. at West Baden, Ind. Mr. Williams has spent most of his time in the past sixteen years in the field of highway construction equipment, particularly motor trucks, during which time he has done much toward improving road construction responsibility and technique. Mr. Williams was the originator of what is now the standard questionnaire, and his efforts were largely responsible for the formation of the Joint Conference on Construction Practices. Mr. Williams has been for many years vice-president of the Autocar Sales & Service Company.

R. H. BAKER, of Nashville, Tenn., assistant highway engineer of the State of Tennessee, has been chosen engineer-manager of the Tennessee Road Builders' Association, recently organized. The organization is composed of highway and street paving contractors and Mr. Baker's work will be to promote better contracting conditions and furnish engineering service to the members of the organization. Until March 1 Mr. Baker will remain as assistant state highway engineer, giving half his time to his work with the association.

CARROLL CARLSON, formerly superintendent of the sanitary department of Orlando, Fla., and previously to that time city manager of Moorehaven, Fla., was appointed on Jan. 1 to the position of superintendent of public utilities of Port Arthur, Tex.

A. B. BACKHERMS, resident engineer on construction of the city of Akron's sewage treatment plant, has been appointed sewerage engineer, succeeding J. E. Root, who has accepted a position under Mr. Waite, chief engineer of the new railroad terminal project in Cincinnati, Ohio. LUTHER LARUE has been promoted to designing engineer to fill the vacancy created by the resignation of R. A. Allton, who will take charge of the design for a treatment plant for Columbus, Ohio.

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Philadelphia, Feb. 28, 29 and March 1, 1928.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, March 6-8.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, May 7-10.

AMERICAN WATER WORKS ASSOCIATION, New York; Annual Convention, San Francisco, week of June 11.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual Meeting, University of North Carolina, June 25.

NEW YORK STATE HIGHWAY CHAPTER, Associated General Contractors, will hold its second annual meeting March 14 and 15 at the Hotel Syracuse, Syracuse, N. Y.

THE NATIONAL CONFERENCE ON CITY PLANNING will hold a meeting in Texas May 7 to 10. The meeting will open in Fort Worth, and the sessions will be continued in Dallas, in which city will be considered, among other subjects, "Comprehensive Financing for Comprehensive Planning," "The Relation of the Plan Commission to Other Departments of the City Government," "City Planning Procedure in Smaller Cities," "The Planning of Undeveloped Areas," "Airports and Airways as a Part of City and Regional Planning," "What Is Comprehensive Zoning?" and "Profits in Sound Community Planning."

THE WESTERN WASHINGTON SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS, has elected the following officers: President, Homer Headley, of Seattle, of the Portland Cement Association; vice-president, W. F. Way, of Henry & McFee, and secretary-treasurer, Tom Hunt, of the King County Engineer's office.

THE ENGINEERS CLUB OF PHILADELPHIA will discuss the co-ordination of the construction and maintenance of roads and streets at a meeting March 2. The meeting will comprise afternoon and evening sessions, during which time papers will be read and discussed on effects and control of heavily loaded vehicles and on pavement openings, developments in heavy traffic arteries, quick-hardening cement, light traffic streets and roads and street railway track construction.

THE CONCRETE REINFORCING STEEL INSTITUTE will hold its fourth annual meeting at Biloxi, Miss., on March 19 to 21, at which Dr. John T. Holdsworth, University of Miami, will give an address on "Coming Changes in Industry." There will also be addresses on "New Architectural Possibilities of Reinforced Concrete" and "Fabricating and Selling Costs of Reinforcing Steel." The joint building code will be submitted by the committee on engineering practice. M. A. Beeman, Tribune Tower Building, Chicago, is secretary.

THE ST. PAUL ENGINEERS SOCIETY has elected the following officers for 1928: President, L. O. Painter; vice-president, C. L. Motl; secretary, Albert Buenger.

THE NATIONAL FIRE PROTECTION ASSOCIATION will hold its 32d annual meeting in Atlantic City May 7-10.

Obituary

VIRGIL Z. WHALEY, formerly city engineer of Kokomo, Ind., died recently in Hollywood, Calif., where he had gone for his health.

GEORGE PERRY GRIFFITH, president of the Griffith Company, one of the largest highway construction concerns in southern California, died at his home in Los Angeles, Calif., Feb. 12 after an illness of five weeks. He was born in Erie, Pa., May 8, 1868, and at the age of 18 entered the employ of the Barber Asphalt Paving Company. In 1901 he moved from Scranton, Pa., to San Francisco and became president of the Alcatraz Paving Company. Five years later he became vice-president of the Fairchild-Gilmore-Wilton Company, paving contractors, and this firm was succeeded by the Griffith Company in January, 1923.

JAMES W. NELSON, formerly president of the Brooklyn (N. Y.) Engineers Club, died on Feb. 16 in Altadena, Calif., where he had gone several years ago for his health. He was 60 years old. For many years he specialized in designing and developing high-pressure hydrostatic machinery. He was a member of the American Society of Civil Engineers and the American Society of Mechanical Engineers.

STURGIS H. THORNDIKE, president of the New England Section of the American Society of Civil Engineers and widely known as a consulting engineer, died in Boston on Feb. 16 after a short illness. He was 59 years old. Mr. Thorndike received his A.B. degree from Harvard in 1890 and his B.S. degree from Massachusetts Institute of Technology in 1895. From the latter date until 1913 he was employed in Boston municipal works and then entered the engineering firm of Fay, Spofford & Thorndike. He was a member of the American Society of Civil Engineers, American Water Works Association, New England Water Works Association, American Society for Municipal Improvements and the Harvard Engineering Society.

Railroad Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

New Portable Air Compressor for Railroad Work

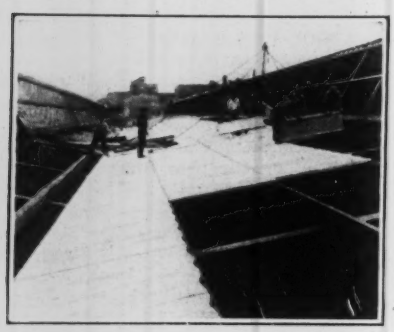
A new line of portable air compressors, railcar-mounted, recently developed by Metalweld, Inc., Philadelphia, Pa., embodies many new features. Force feed lubrication assures proper oiling. The bevel gear drive is claimed to eliminate all trouble arising from slippage. Laidlaw feather valves and counterbalanced crankshaft cause the

engine to operate with an unusual lack of vibration and to supply a large reserve power.

Other improvements include grease packed ball-bearing journal boxes, cast-steel turned wheels, automobile type brakes, air-cooled ball-bearing clutch and electric starter, and a simplified derailing process which enables one man to complete the operation without any distortion of the frame or danger of injury to the machine.

New Precast Concrete Roof Slab

Suitable for use on railroad structures, factories, water works, theaters and schools, the new precast reinforced concrete roof slab known as the "Light Six" has been developed by the Federal Cement Tile Company, Chicago, to embody a number of advantages. The most important of these is claimed to be the saving in steel in the supporting super-structure that the use of the new roof slabs effects by virtue of its light

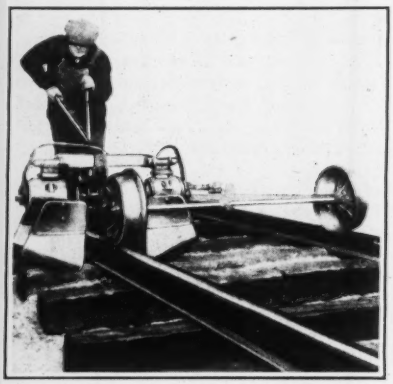


weight of 16 lb. per sq.ft., and its long span of 6 ft.

The "Light Six" is a channel slab, 6 ft. long by 24 in. wide with steel reinforcing properly positioned for greatest resistance to stress. It is manufactured at the company's plant in a rigid steel mold with the steel reinforcement firmly fixed. The steel mold imparts a smooth finish to the slab so that, it is claimed, ceilings under completed roofs may be saved in most types of buildings. Advantages claimed for the precast concrete roof are long life, freedom from paint and repair cost, and fireproof construction that also resists smoke, water, and gases. Ease in erection is also important since the units may be hoisted direct from box cars to the roof.

Electric Gravel Tamper of Unique Design

A new machine recently developed by the Electric Tamper & Equipment Co., Chicago, is designed to replace shovel tamping of the lighter types of ballasting material and is known as the Jackson High-Speed Gravel Tamper. The tamper is operated by electricity. The manufacturer claims that its use will effect a definite economy over shovel

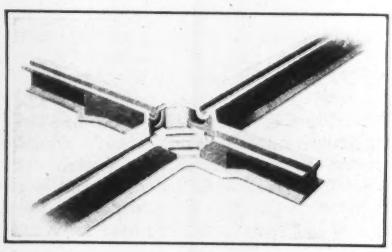


tamping, and at the same time will insure a uniformity of track surface that will reduce the necessity of spotting to a minimum.

The speed in track feet per hour depends upon the number of tampers employed. The two unit outfit uses a right and left-hand tamper, one on each rail, and has a capacity of 200 to 250 track ft. per hour. The tampers and generating unit are portable and can be moved from the track within a few seconds. The power units are the same as those used for the operation of the standard Jackson electric tie tampers which have been in use for a number of years. The blades have the shape of shovels and exert a simultaneous tamping action on each side and under the tie. There is also a slight rotary movement of the blades which is designed to work the ballast inward beneath the rail.

Track Crossing Designed by Mechanical Analysis

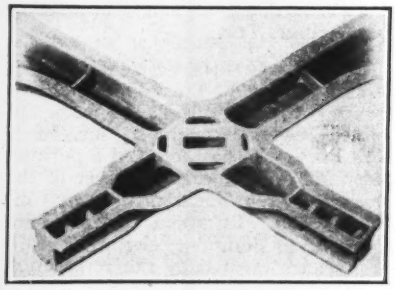
As a result of an unusually scientific study of track crossing structures, in which both the Beggs deformeter and the Sayre polarized light analysis methods were used, Wm. Wharton, Jr. & Co., Inc., Easton, Pa., has developed a track crossing, both the top and bottom of which are illustrated herewith. The crossing is for use on heavy steam railway crossings and for electric railways where they cross steam runs. The company claims it to be the first crossing scientifically designed to withstand



TREAD SURFACE OF NEW CROSSING SHOWING INTERSECTION

the working stresses to which it will be subjected in service. Study was made from two major viewpoints: from the engineer's in order to create a design affording minimum unit stresses and from the foundryman's in order to assure a section which would cast soundly throughout.

In making the engineering study the cross-sections proved to be of an indeterminate character and therefore impossible of mathematical analysis. Therefore, the Beggs method of analysis of stress in structure by the use of elastic models was resorted to. Typical steel crossing sections were selected for analysis, the cross-section laid off into a number of areas, such as area under the tread surface, under the groove, sidewalls, and base flanges. By the use of the Beggs deformeter and a microscope the stresses were studied with the crossing deformed as under service loading. Then to check the truth of these results an independent investigation was made employing the photo-elastic model method of polarized light analysis de-



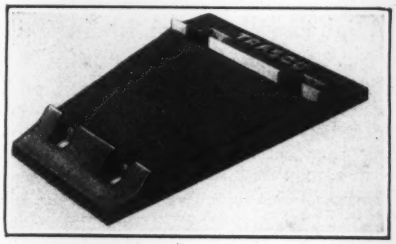
BOTTOM OF NEW CROSSING SHOWING BOX SECTION

veloped by Prof. Mortimer F. Sayre of Union College. This investigation produced, it is said, results remarkably close to the values determined by the Beggs method.

The salient features of the design as adopted from the investigation are as follows: Uniformity of metal sections under head and groove surfaces; no supporting members joining the under side of the tread and groove metal; bottom grid or floor makes a box type of construction resulting in unusual resiliency, and avoiding excess weight; cross members in the arm sections form a strong tie to prevent the side walls from spreading, but do not come in contact with the under side of the tread or groove surface, thus avoiding interior defects that frequently cause cupping in the tread surface; side walls are tapered in thickness, being thicker at the top where they join the under side of the tread and guard sections. This feature decreases the unit stresses in the groove section and enables a transition of metal sections from the thick tread to the thin outer flange of the base, a condition that is very favorable toward sound castings.

Efficiency Features of Trapezoidal Tie Plates

A tie plate, trapezoidal in form, with the longer base on the outside or heel, and with shoulders on both the inside and outside, is being introduced by the Track Specialties Company, 29 Broadway, New York City. A number



of advantages over the ordinary rectangular plate are claimed. The trapezoidal shape provides the larger area of plate outside of the center line of the rail where the greater proportion of the pressure is concentrated since the resultant of the vertical and lateral forces intersects the tie plate at some point in this outside area. Because the plate is wider on the outside than on the inside, it is claimed that any settlement will be more uniform than in a rectangular plate.

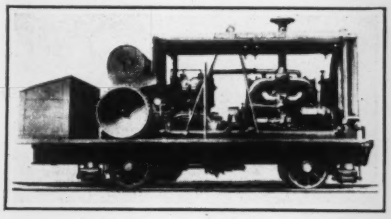
A further advantage lies in the provision for eccentricity. The Track Specialties Company points out that in the rectangular plate the resultant must pass through the center of the tie plate in order to equalize the pressure, and that this center being outside of the center of the rail, it is necessary to use an extra long heel; and lengthening of the heel in turn necessitates an increase in the thickness of the plate. In the trapezoidal plate, however, the eccentricity is provided for in a more economical way since the center of gravity of the tie plate is naturally outside of the center of the rail. Another advantage pointed out is that a relatively short heel is necessary, which permits a thinner plate than is possible with a rectangular plate.

It is claimed that a trapezoidal tie plate 9 in. long, 8 in. wide on the outside and 4 in. wide on the inside with the center of the rail coinciding with the center of the tie plate will give the same level settling as a rectangular plate 10 in. long with an eccentricity of ½ in.

By designing the plate with a shoulder on each side of the rail and with a uniform cross-section each side of the center line the plate can be cut in trapezoidal form without loss of metal such as would occur were the cross-section not symmetrical about the center line.

New Self-Propelled Compressors for Railroad Service

A new line of self-propelled gasoline engine driven compressor cars for railroad use has recently been announced by the Chicago Pneumatic Tool Co., New



York City. The machines are built in sizes of 100, 160, 220, and 310 cu.ft. per minute displacement. They consist of the standard Chicago Pneumatic portable units set on a structural steel frame, mounted on flanged roller-bearing equipped wheels. Flanged transverse wheels, air-operated lifting jacks, and a transverse towing winch make it possible for one man to shift the car from the main line tracks to a siding in less than one minute. Equipment includes locomotive lifting bale, large equipment box, wide platforms extending over the wheels on each side, and trailer-type drum brakes fitted to the two front wheels. The self-propelling mechanism embodies a two-wheel drive which propels the car at a speed of 12 to 18 m.p.h.

The compressor unit embodies the same distinctive features as the company's industrial portable compressor, which include an automatic air-operated throttle which slows down the engine when the compressor unloads, sectionalized radiator protected by steel bars, detachable flexible coupling between the compressor and the engine, and a one-piece cast steel deck on which the compressor, engine and accessories are mounted.

Full-Revolving Track Crane for General Service Work

The new track crane recently developed by the Nordberg Mfg. Co., Milwaukee, Wis., has not only been designed for track laying but also for loading and unloading rails and for handling bridge steel and other heavy materials. An important feature of the machine is that it is full revolving, operating in either direction at a speed of 3 r.p.m. on a ball-bearing turntable. The machine is known as the TracKrane and has a capacity of 5,000 lb.

The frame is 6 ft. by 12 ft. 8 in., while the revolving platform is 6 ft. by 10 ft. by 9 in. These are both made from channel plates with all joints welded. The boom is channel-plate-and-lattice type, with a normal length of 26½ ft. and provision for extension to 35 ft. A two-part, ½-in. line is used. There are two hoisting speeds, 90 and 180 ft. per minute. The boom hoist is of the self-locking, worm and gear type, and uses three-port boom lines of ⅝ in. rope.

Special attention has been given to provision of a safety-type hoist upon which the brake automatically sets as soon as the power is disengaged from the hoist drum. Lowering a load is accomplished by power and is not dependent upon the brake. The drum is driven by worm and gear through multiple disk clutches, all inclosed.

The machine is powered by a 40-hp., four-cylinder gasoline engine and is self-propelled in either direction at speeds of 5 and 5½ m.p.h. Two methods of braking are provided, brakes being on all four wheels. One type of brake is automatic and set in operation when the operator takes his foot from the traveling pedal. The other is a hand brake for emergency purposes. Clamps are provided at either side to tie the machine to the rails when heavy lifting is required. Run-off wheels are also provided to permit quick removal of the machine from the track.

Manufacturers and Trade Associations

Calendar

Annual Meetings

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Annual meeting, Biloxi, Miss., March 19-21.

SOUTHERN PINE ASSOCIATION, New Orleans; Annual meeting, New York City, March 26-28.

AMERICAN WATERWORKS MFGRS. ASSOCIATION, New York City; Annual meeting, San Francisco, Calif., June 11-14.

New Publications

Railroad Equipment—WORTHINGTON PUMP & MACHINERY CORPORATION, New York City, has published bulletin No. WP-1000 illustrating and describing the equipment which it manufactures for railroads. This equipment includes pumps, air compressors, steam condensers, oil engines, water and oil heaters and feed water heaters.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Railroad Construction Most Active in the West

The reports received by *Engineering News-Record* during the last half of 1927 and the first seven weeks of 1928 show a marked sectional tendency in railroad construction. These reports cover various types of work—repairs, extensions, and improvements to roadway—valued at $25,000 or more.

Proposed work consists mainly of projects in the region between the Mississippi and the Rocky Mountains. During the last six months of 1927, 89 per cent of the value of contemplated work was reported for this section and each of the other main geographical divisions reported 3 per cent or less. Texas alone accounted for 46 per cent. Thus far in 1928, 37 per cent of proposed work was in this section. The outstanding report, however, covers plans of the Northern Pacific Ry. Co. for expenditures amounting to $13,500,000 during 1928.

Contracts awarded for railway construction since July 1, 1927, to date also show the states West of the Mississippi to be in the lead, with 50 per cent of the total value and 57 per cent of the number of awards.

In general, less new work was done on the railroads in 1927 than in the preceding year, according to the *Railway Age*. New lines completed were 22 per cent less than in 1926, but the record for 1926 showed a 54 per cent increase over the record for 1925. The South and the region West of the Mississippi had, respectively, 28 and 35 per cent of the total new mileage completed in 1927.

Business Notes

The Federal Reserve discount rate was increased to 4 per cent by the Philadelphia and Atlanta banks on Feb. 16 and Feb. 11, respectively.

Inquiries for structural steel in Pittsburgh last week were reported to have been 50 per cent greater than for any other week this year.

This Week's Contracts

Heavy construction contracts reported by *Engineering News-Record* in the week ended Feb. 23, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Feb. 23, 1928	$11,933	$51,000	$62,933
Feb. 16, 1928	16,946	28,755	45,701
Feb. 24, 1927	10,742	26,534	37,276
Jan. 1 to date:			
1928	136,827	274,821	411,648
1927	107,588	249,422	357,010

E. N.-R. Index Numbers

Cost		Volume	
Feb. 1, 1928	**204.65**	**January, 1928**	**208**
Jan. 1, 1928	203.90	December, 1927	319
Feb. 1, 1927	210.15	January, 1927	187
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913	100.00	1913	100

Industrial and Foreign Bonds Lead Week's Offerings

New bond offerings for the week ended Feb. 17, 1928, were valued at $88,937,894, for the preceding week at $151,669,500 and for the corresponding week last year at $53,502,550, according to the *Wall Street Journal*. The Monday holiday probably partly affected the amount of new offerings, and this week the Wednesday holiday will have a similar effect. Of the recent aggregate weekly offerings the percentage for each class was: public utility, 12.6; industrial, 23.7; municipal, 10; foreign, 22.2; real estate, 14.7; miscellaneous, 16.8.

The city of Porto Alegre, Brazil, recently secured in the United States a loan of $2,250,000 for completing waterworks, paving, sewers and other city improvements. A large volume of Cuban financing will reach the market soon. A short time ago the Republic of Cuba was reported to be contemplating a $50,000,000 loan to speed up its national road-building program. The city of Havana is now considering an American loan of $7,000,000 for boulevards.

Some of the more recent bonds offered are listed in the table below.

RECENT IMPORTANT BOND OFFERINGS

		Interest Rate	Yield	Due
Public:				
California	$4,000,000	4	3.80	Feb. 1, 1932–1949
Maryland	1,815,000	4¼	3.70	1931–1943
South Dakota	2,175,000	4.20	4 to 1933 4.20 thereafter	March 15, 1948
Cheektowaga, N. Y.	948,894	4.30	3¼@4.10	Serial
Suffolk Co., N. Y.	889,000	4¼	3.65@3.80	Serial
Fulton, N. Y.	118,000	4	3.75@3.85	1929–1938
Montgomery, Ala.	600,000	4½	4.10@4.15	April 1, 1931–1958
Palm Beach, Fla.	905,000	5	4.60	June 1, 1931–1946
Industrial:				
The Ohio Power Co.	10,018,000	4½	4.75	June 1, 1956
Pittsburgh, Steel Co.	11,000,000	6	5.90	Feb. 1, 1948
Spang, Chalfant & Co., Inc., 1st sinking fund	7,000,000	5	5.08	1948
McCord Radiator & Manufacturing Co.	2,500,000	6	6.05	Feb. 1, 1943
Fruit Growers Express Co., equip. to etfs., Series H	1,875,000	4¼	4.15@4¼	Serial
Foreign:				
Republic of Finland	15,000,000	5½	7¼	Feb. 1, 1958
Dept. of Antioquia (Columbia)	3,750,000	7	7.45	1945
Miscellaneous:				
Commercial Investment Trust Corp., convertible debenture	15,000,000	6	6	1948

New York Brick Sales Smaller; Supply Greater; Prices Firm

The construction materials market has shown unusual firmness throughout the last three weeks, despite the fact that February is normally a month of price decline. Changes of the week were few.

Brick prices did not change, though sales in the New York district dropped 29 per cent in the last week. Six more barges arrived this week than last.

The price of wood lath rose 50c. to $8.50 per M. at New York during the last week. Lump finishing lime dropped 25c. per 280-lb. (net) bbl., to $4.25 delivered in this district.

The trend in non-ferrous metals continues downward, with buying for immediate needs only. A protracted decline, however, is usually necessary in the raw metals before prices of sheets, tubes and other fabricated materials entering into building construction become affected.

Steel prices continue to rise, the most recent increase being $2 per ton for hot-rolled strips. Current steel demand consists mainly of railway material, structurals and pipe. The operating rate of Steel Corporation mills is now close to 90 per cent of capacity, having gained 2 per cent in a week. Bars, plates and shapes hold firmly to the price of $1.85 per 100 lb., Pittsburgh, for carloads. Recent mill advances have not, however, affected warehouse quotations on the principal hot-rolled materials.

Highway Planning Distribution Analyzed from Proposals

Analysis of a year's reports of proposed street and road work, as published in Construction News, shows some interesting facts. Among them is the confirmation that spring is the planning period. On the basis of value of contemplated work during the last two years, January, March, April and December are the peak months. The size of the January and December totals must be qualified by the fact that numerous state highway departments announce general road expenditures for the following year at that time, despite the fact that plans may have been made in advance. Specific road programs are decided in most cases in the spring.

The accompanying table shows how much of the yearly total of planned work was announced each month.

PER CENT OF YEARLY TOTAL NUMBER AND VALUE PROPOSED IN EACH MONTH

	1927		1926	
	Number	Value	Number	Value
January	11.8	8.0	10.0	14.0
February	11.4	6.2	9.5	13.0
March	14.4	10.6	10.3	7.8
April	12.0	9.9	8.9	12.0
May	14.9	11.4	8.7	3.9
June	10.0	6.2	9.1	6.6
July		5.8	7.7	5.4
August	4.0	8.0	7.5	3.8
September	3.7	5.2	7.4	6.2
October	6.8	5.7	6.8	6.0
November	7.4	4.6	7.2	7.8
December	3.6	18.4	7.1	13.5
	100.0	100.0	100.0	100.0